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Molding an Engine Standard and Cylinder—II.

BY J. HORNER.

In my last article I described the molding of the pattern and the making of the main core. In this article I describe the making of the remaining cores and the completion of the mold. I do not, however, think it necessary to give separate illustrations of core *R* and the jacket core *S*, all in place ready for the cope. Fig. 7 is a longitudinal section through the completed mold as ready for pouring, and Fig. 8 is a transverse section through the cylinder and the exhaust passage taken on the line *X*—*X* in Fig. 7. In these figures *B* is the drag and *T* the cope. There are also shown the main core *Q*, the cylinder core *R*, the jacket core *S*, the steam chest core *U*, the bearing cores *V*, and the cores *W* between the bearings and the main sage core is narrow, while the jacket core embraces about three parts of a circle. Being slender it has to be well supported with grids, and having a large area it has to be well vented.

The grid is shown in Fig. 10 just as it appears when fitted around the body of the core-box before referred to ready for the ramming of the core. Three thin cast-iron plates *f f f* are made to the outline of the core, leaving a little for sand beyond their melts, and then the strings can be withdrawn easily, leaving curved core vents. The air passes from these into the perforated tubes *h h h*, and passes out at the ends of the flask as seen in Figs. 7 and 9. After the casting is made the grid is broken up and got out through the openings left in the cylinder end.

The core is sustained in the mold entirely with chaplets or stops. These are shown at *i* in Figs. 6, 7 and 8.

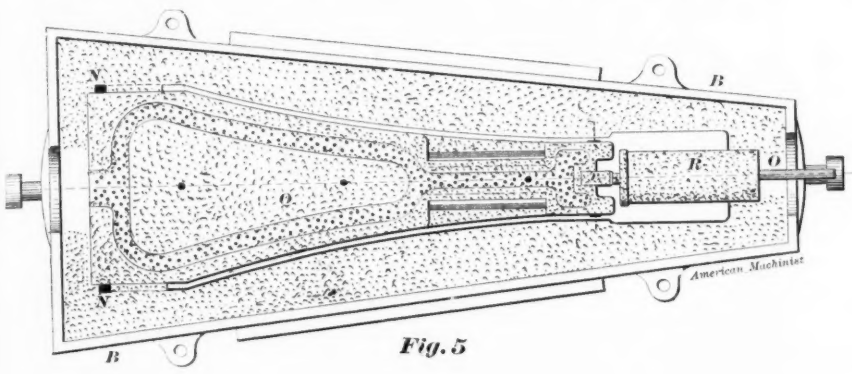


Fig. 5

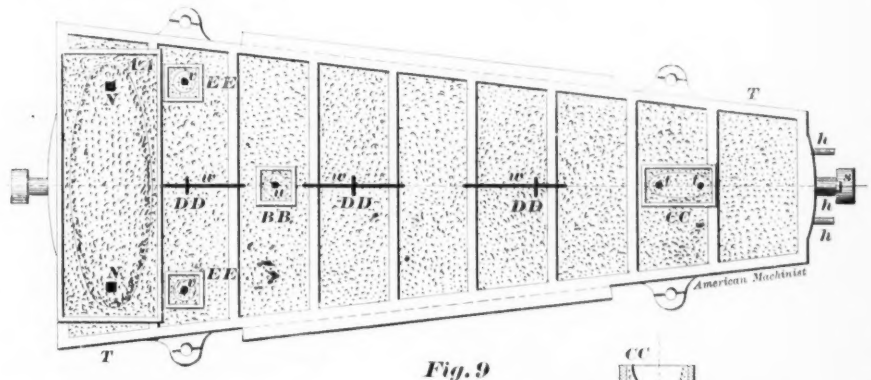


Fig. 9

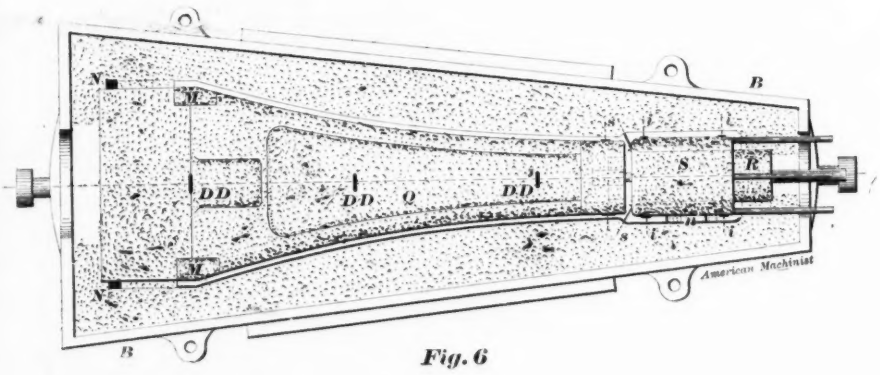


Fig. 6

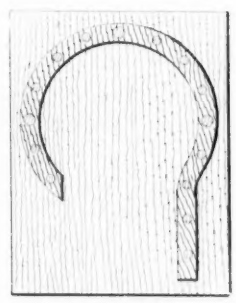


Fig. 11

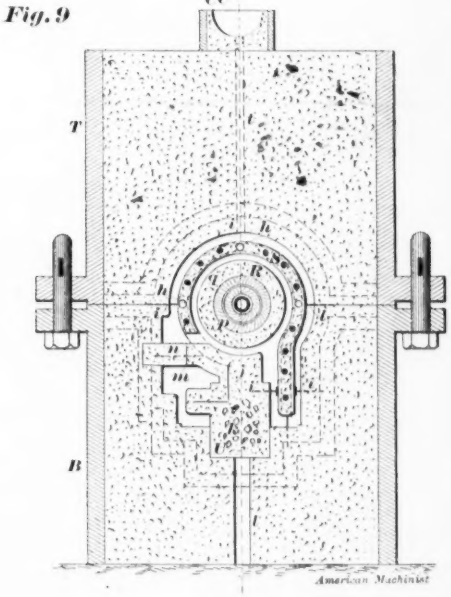


Fig. 8

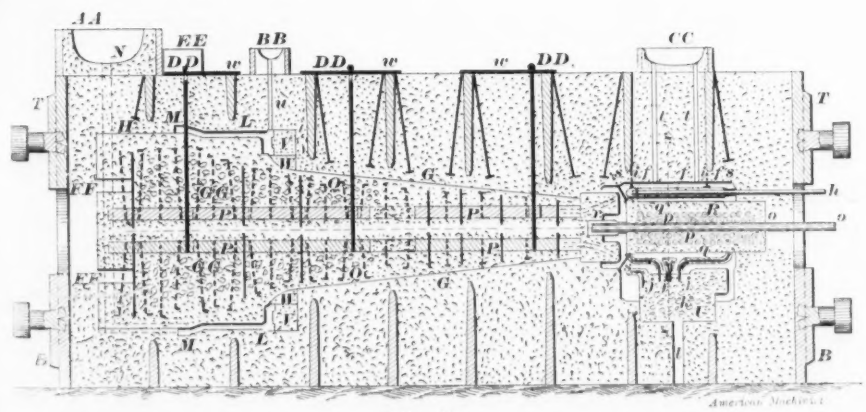


Fig. 7

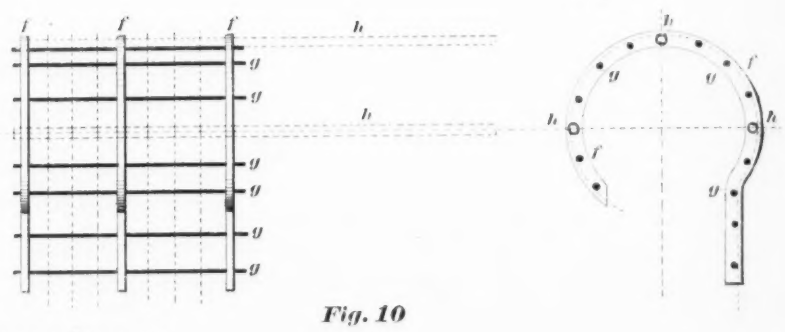


Fig. 10

MOLDING AN ENGINE STANDARD AND CYLINDER.

the cores because they are shown very clearly in the views of the mold comprised in the accompanying figures. These figures comprise the following:

Fig. 5 is a plan view of the joint face of the drag part *B*, showing the bottom half of the main core *Q* before the halves are stuck together, and the cylinder core *R* is seen fitted into it, and the two are being tried into the mold previous to the fitting over of the jacket core. This is done to try thicknesses and the coincidence or otherwise of the cores with their print impressions. Fig. 6 shows the main core *Q*, the cylinder core *Q*. Fig. 9 is a plan view of the cope *T*. In this and in Fig. 7 we note the pouring basin *A A*, the riser cups *B B*, *E E*, the eyes *D D* coming up from the main core *Q* and many other details which we will now notice more particularly.

The most troublesome core to make is the jacket core *S*. Figs. 6, 7, 8. It is made in the box shown in Fig. 17 in the issue of AMERICAN MACHINIST for September 28th. It is difficult to make because it is of so slender proportions, in this particular case only ¾" thick. In this respect it much resembles an ordinary steam passage core, only that a passedges. The pattern for these is shown in Fig. 11. It is nailed on a back board because it is too fragile to stand without support, and prints are put on for the holes. These holes carry the rods *g* in Fig. 10 and the vent tubes *h h h* in the same figure. In order to bring the air from the core into these tubes vent strings are rammed up in the core, and afterwards withdrawn. The positions of these strings are indicated by dotted lines in Fig. 10. The best way to insure getting these strings out easily is to incase them with tallow. I have often seen candle wicks used. As the core dries the tallow melts, and then the strings can be withdrawn easily, leaving curved core vents. The air passes from these into the perforated tubes *h h h*, and passes out at the ends of the flask as seen in Figs. 7 and 9. After the casting is made the grid is broken up and got out through the openings left in the cylinder end.

But the core is not actually put in the mold yet. The steam chest core has to be made and put in first, and the cores *Q* and *R* tried in.

The steam chest core is made from the box which I illustrated in the second paper on the pattern work. The peculiarity of the core is that it includes not only the steam chest but also the steam passages, and the curved portion of the exhaust. This causes the core to be somewhat difficult to make, but it saves a deal of trouble and risk that would be incurred if the passage and exhaust cores were made separately from the

steam chest core. Speaking generally it is better to adopt this method whenever these cores have to be set in the bottom of the mold instead of in the joint face.

No special grid is necessary for this core, but rods *j* are rammed up in it, going well into the body of the core. A central space *k* is filled with ashes, and the air is brought off down to the bottom of the flask through the channel *l*. The core fits into the impression made by the print *D* in Fig. 1, shown in the last paper.

In order to get the core in it is necessary to terminate the exhaust branch at *m* in Fig. 8. The supplementary piece *n* is put to its print on the side of the cylinder *F* in Fig. 1, see last paper, and the main core then will pass down by it. A short length of round core for the steam inlet is also put into the impression made by the print *E* in Fig. 1. This is seen in Fig. 6.

The core *R* for the cylinder bore is struck against the edge of a board, shown in Fig. 16 in the second paper, descriptive of the pattern work. It is struck up in the way common to this class of work upon a perforated core bar *o*, around which hay bands *p* are wound and loam *q* worked between and around the bands. That end of the core *r*, which forms the stuffing-box, consists of a thin body of loam only, struck directly upon the bar. This end is thrust into a print impression of the same diameter which is formed in the main core *Q*. This print is seen at *r* in Fig. 3 in the last paper.

The vents from the cylinder core pass through the hay bands *p* into the perforated tube *o*, and out at the end of the flasks. The core is supported partly at the end *r*, partly at the opposite end in the impression formed by the print *C'* in Fig. 1, in the last paper, and is steadied further with chaplets *S*.

The cores *V* for the crank-shaft bearings and the cores *W* that fill up the spaces between *V*, *V* and *Q* scarcely call for remark. Those which come in the drag *B* are laid down in their print impression before *Q* is lowered into place. Those which come in the cope *T* are fastened in the cope. Or they may alternately be fastened on the top of the main core *Q*, their positions being found by lowering the cope with the cores wired in place down upon *Q*.

The cores *Q R S* are all put in place together. A glance at Fig. 8 will show that the jacket core *S* will not pass down over *R* after the latter is in place. And a glance at Fig. 7 will show that the cylinder core *R* cannot be put in after the jacket core *S* is fixed. Therefore the three cores are put in together, *R* being thrust into *Q* and *S* threaded over *R*, and they are set together by the prints, and by the chaplets already set in their positions. The services of three or four men are required to steady the cores in safety in addition to the man at the crane who lifts the main core by its eyes *D D*.

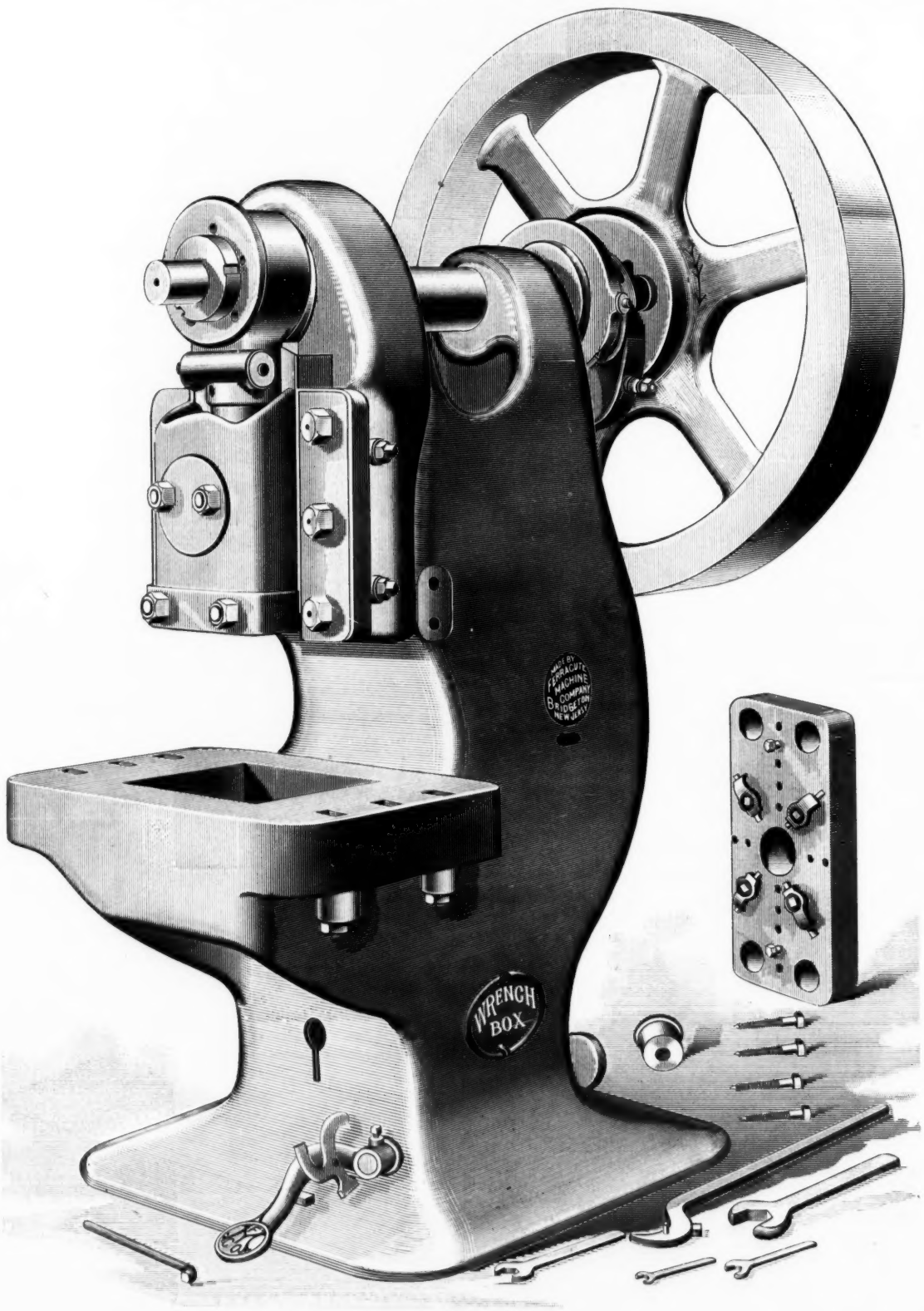
The remaining matters which call for remark are the following: There are risers *t t* from the jacket core coming up into the riser cups *C C*. These conduce to soundness of metal around the jacket because they allow the sullage to float upwards into the cup. There is also a riser *U* over the top bearing *V* coming up into the cup *B B*, and two others *v v* directly over the bosses *M M* for the hold-down bolts, which come in the cope. The riser cups for *v v* are shown at *E E*.

At *w w w* rods are shown. These pass through the eyes *D D* of the main core *Q*, and help to support and steady it. The vents from the main core are brought out at *F F* through the ends of the flasks.

At *G G* in Fig. 7 the central spaces filled with ashes, which were referred to in the last paper, are seen.

There are several matters of detail shown in these drawings to which I have made no special allusion. The shapes and positions etc., of bars, lifters, pins and cotters call for no remark, being well understood by those who are interested in molding.

To save confusion I have placed the same reference letters against similar parts in the whole of the figures in these two articles, so that references from one figure to another are facilitated.



NEW PUNCHING PRESS.

New Punching Press.

Continuing our illustrations of the new designs of sheet metal working presses brought out by the Ferracute Machine Co., of Bridgeton, N. J., we present herewith an engraving of a punching press which is representative of a full line of similar machines, there being five sizes ranging in weight from about 900 pounds to 6 000 pounds.

The frame of this press is hollow and of very rigid proportions, having the tensile and compressive members of those parts which act as beams arranged with internal ribs. This construction gives great rigidity against torsion in the upright part, back of the throat, so that the upper die is not easily sprung laterally away from true alignment with the lower one.

The pitman is of recently improved construction, its stem, while having the advantage of a screw adjustment, being so firmly gripped both at its upper and lower ends in the pitman-pivot and strap respectively, as to give the effect of solid metal between shaft and ram, these gripping devices at the same time being very delicate in their adjustment.

The ram is unusually heavy, and is arranged with very long and wide bearings; an extra long pitman adjustment, graduated to hundredths of an inch; proper arrangements for clamping various kinds of punches; a positive knockout when desired, etc. The bolster can be made to order with various sizes of central hole, and is provided with die clamps, adjustable in T-slots upon the top face.

The shaft is of forged steel, with unusually large and long journals. In an enlargement of its solid metal is mounted an automatic stop-clutch, which was described and illustrated in detail in our issue of October 5th.

The dimensions of this press are as follows: Hole through bed, 12″x14″; throat, from ram center back, 12″; height of bed to ram at top of stroke and adjustment, 11″; standard ram stroke, 1½″; special stroke to order, anything up to 5″; adjustment of ram, 3″; fly-wheel, 50″x8″; weight of fly-wheel, 1,700 pounds; speed of fly-wheel, 80 revolutions per minute; thickness of iron punchable with one-inch round dies, ¾″; thickness of bolster, 4″; pressure safely exerted by ram, 68 tons.

Notes from the Fair.

Editorial Correspondence.

Those who are interested in wood working machinery, and have watched its development, find much at the Fair that is instructive. Progress in this line of manufacture has been rapid during the past few years, not only in the designing of machines for new purposes, but in the perfecting of existing types of machines. Old standard machines have taken new forms more in harmony with present ideas of machine design. A good deal of the wood-working machinery of the past had the appearance of being thrown together rather indiscriminately, as if its various members were originated without much reference one to the other, and made to perform their concerted functions in the best way that could be conveniently come at. It lacked character, so to speak. This is, of course, mainly of the past, although at the Paris Exposition it was in many instances quite noticeable. To those who can look back twenty or thirty years, the improvements that have been made are especially interesting. Cutting speed has been increased because better construction has made doing so both possible and practicable. The quality of truth in the product has, rather as a matter of course, kept pace with the same quality in construction, and hand-work as a factor has been eliminated in a remarkable degree. The modern wood working machine or set of machinery must leave the work complete in every particular. There is nothing uncertain in the operation of such machinery, and its construction is away past the point where almost anything would do for a machine that "only whittled wood." What is wanted nowadays are machines that look well and that will do a good deal of good work and give the attendant the minimum of trouble and labor. And a view of the exhibits at Chicago makes it rather plain that that is what the best manufacturers are furnishing. It is "labor saving" machinery in the complete sense of the term.

The largest individual exhibit of this class of machinery is by the J. A. Fay & Egan Company, of Cincinnati, O., who have about fifty machines for performing the various operations on wood for which machinery is adapted, so far as can be done by that limited number out of about a thousand varieties made by this firm. The statement of the great variety of machines made by a single firm need not discourage any one desirous of going into the business of fashioning wood, and who knows that to compete he must have the best modern machinery. The great variety is required to suit the equally great variety of requirements, giving to a purchaser not simply a machine that will do work of the class he is doing, but one that will exactly meet the requirements of the peculiarities of his particular work. Wood varies in its physical

qualities through a wide range, and is susceptible of being given an almost endless variety of forms, and as in this as in most other things fashion is fickle, the manufacturer of wood working machinery must meet many and diverse conditions of utility and ornament to suit the tastes of his customers.

The readers of the AMERICAN MACHINIST are from time to time made acquainted with the machines built by this firm. I need only say for this exhibit that the various machines are well finished, and, of course, well made.

P. Pryibil, New York, has several of his well known machines for working wood in his space, most of which we have shown at different times. Amongst others I noticed a 24 inch planer, the feed for which is a friction disk. It will be understood by those familiar with this kind of feed motion that with it the feed can be instantly changed from the coarsest to that of any degree of fineness, or *vice versa*, and that it can be instantly reversed, "backing out" the piece being operated upon. The advantage of this is that when a hard spot is struck, or likely to be, the operator can reduce the feed without trouble—the particular emphasis being on trouble—thereby saving a piece that might otherwise be torn out and ruined.

A German firm, Ernest Kircher & Co., of Leipsic, make an extensive exhibit, covering the more common kinds of wood working machinery. In their exhibit is a large band-saw for sawing logs, and a large number of smaller band saws. This firm make these saws for logs up to seven feet in diameter. They also show a gang mill made with iron housings and about as elaborate in all respects as an iron planer, of which it reminds one in some respects.

There is, besides those mentioned, a large number of excellent exhibits of wood-working machinery from this and other countries.

There is an object lesson in judicious co-operation in the joint exhibit of N. P. Bowsher, of South Bend, Ind., the illustration of whose balancing ways our readers will remember, and the MacKinnon Pulley Co., of Menasha, Wis., who make the O. C. Little separable pulley, coupling and collar. This pulley is made so that a portion of the rim between two arms can be removed, or swung back so as to leave an opening that will pass over the shaft, and a section of the hub is removable for the same purpose. Fig. 1 will give a good idea of how the pulley is made, showing the opening in the hub, and Fig. 2 represents one of the bolts that hold the removable part of the rim in place. It will be seen that the bolt holes—the holes for the heads of the bolts—are made beveling or dovetailing in all principal directions, so that screwing the nuts up hard does not tend to separate the parts of the rim. It might at first glance be thought that a good deal of fitting—trimming—would be required in getting these pulleys together, but the fact is there is almost literally none. The loose section of the rim is cast in place, with the bolt holes and edges of the rim that come together remarkably smooth and accurate, by a process Mr. Little has devised, and the recess for the removable part of the hub, as well as that part, require no fitting. Just how the pulley is placed on the shaft is so evident as to require no explanation. The hub of the pulley is a little heavier than that of an ordinary pulley, but, as the inventor remarked, "Cast iron is cheap."

Co-operation is not always a success; it is here, and this is how it works: By removing the loose section of the pulley rim, the latter is thrown very materially out of balance. Mr. Little—who tends strictly to business, and gets some—mounts a pulley, with this section removed, on a short shaft and the whole on a pair of Mr. Bowsher's balancing ways, and sets it oscillating rather violently, the slight friction permitting oscillation for a long time. Every one who passes appears to be seized with an unendurable curiosity to know just what the intent of the exhibit is anyway, and before this curiosity is satisfied finds out a good deal about both of the exhibits. It is a dull day in Machinery Hall when the exhibitor is without an audience, and he answers such questions as "Will that machine make anything but pulleys?"—which I heard asked by a man who, from general appearances, was a good way above the average in intelligence—with the greatest good nature.

Mr. Little has patented processes in the molding of pulleys which enable him to do that part of the work very cheaply.

The display of gas engines is probably a fair indication of the hold this form of motor has on the power-using public. Germany, as might be expected, comes well to the front in this line. Germany is, so to speak, the home of gas engines, and it will be a hard matter to crowd her from first place. Take for example the exhibit of the Otto Gas Engine Works, Schleicher, Schumm & Co., of Philadelphia. Over this exhibit

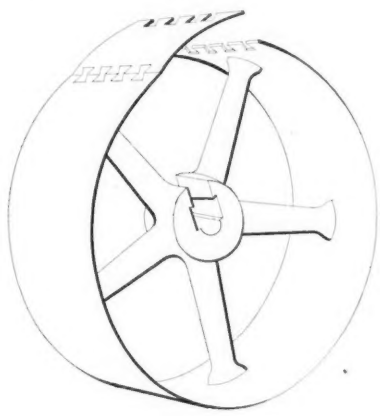


Fig. 1.

is the legend, "40,000 in use." This firm has in its main exhibit ten engines, some of which are always in operation. One is reminded that gas engines for moderately large power are working their way into use by seeing one of 100 horse-power, while the smaller ones are represented by one of only one-third horse-power. This last named is an extremely neat vertical engine that there ought to be room for in many places. The 100 horse power is a double-cylinder engine with one cylinder over the other, and a single crank-pin. There is another engine of 50 horse power and others—horizontal and vertical—of intermediate sizes. The Otto Company worked for a long while, here and in Germany, to the end of getting an electric igniter that should be without objectionable features, and now furnish engines with or without it, as desired, or as seems best suited to the purpose for which the engine is required, and the conditions attending its use. In addition to the Otto

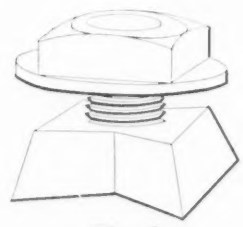


Fig. 2.

gas engines built in this country there are those built in Germany, which make a fine display in the German section. A row of these stand next the center aisle in Machinery Hall, the fly-wheels in accurate alignment, diminishing in size down the line like the individual members of a military company on dress parade. This exhibit is admired for its tasty arrangement and for the fine finish of the engines.

There are several other exhibits of gas engines both from builders in this country and in Europe, but those mentioned are the most extensive and complete.

The Crescent Steel Company, of Pittsburgh, Pa., have some of their products on exhibit—steel shafts, special drill rods, broken ingots, etc. Their most notable exhibit, however, is a large variety of small tools—taps and dies, reamers, etc.—made from their steel. Amongst them is a hob for cutting large worm-wheels, made by the Moline (Ill.) Elevator Company. This hob is about 7 inches diameter and 10 inches in length. A similar hob is shown which looks scarcely worse for wear after having been used for cutting 50 wheels. One of the branches of this company's business is the furnishing of special steel for any kind of cutting tools, different kinds of steel being furnished for different kinds of tools, also steel springs, and steel for all kinds of springs, as shown in different parts of their exhibit.

William Jessop & Sons, Limited, Sheffield, England, and 91 John street, New York, make a good display of steel castings, unannealed, consisting of gear wheels, cams, cross-heads, car wheels, etc. Some of the castings have been broken or bent cold, and some have been forged into tools such as chisels, knives, razors, etc., evidently to show the toughness and other qualities of the steel. There are also shown large and small circular saw plates, and a band saw 12 inches in width and 54 feet long. There is a collection of more than a thousand fractured sections of tool steel, some hardened and others soft, steel bars and the American flag with alternate stripes of black and polished steel with nickel-plated steel stars. Their display is very pleasingly arranged, and is instructive.

Professor Sweet has referred to the exhibit of Stumm, of Germany. This is one of those exhibits that must be seen to be appreciated, and about which little can be written. Taken as a whole it is by many considered the masterpiece of the Fair in the arrangement of its parts. There are not only masterly productions of the forge and mill in the way of sections of great length, but the obelisks made of pieces of these sections could scarcely be more beautiful if the pieces had been made especially for the purpose.

Behind the Stumm exhibit and partly hidden from observation is another German exhibit scarcely less noticeable. One of the pieces in this exhibit is a wrought-iron welded pipe with flanged outlets or nozzles, one near the center of its length, and loose collars at the ends. This pipe is 65½ feet in length, 31 inches diameter and weighs 3½ tons. The thickness of metal is five-sixteenths of an inch.

Another piece is a wrought-iron Y pipe—knee pipe it is called—about 16 inches diameter, the union of the branches with the main stem being simply perfect.

Of course it is the easiest thing in the world to say that these and a good many other things not mentioned can be made anywhere, in fact, this is about the most common form of argument one hears. It seems to me this is not fair; the matter of importance, and the question at issue is, *Where are* they made?

Near the exhibit just referred to is another German exhibit of rolled iron ornamental sections, the raised figures upon which are equal to those on good castings. This kind of work in small sections is made, I am told, so as to be sold at a low price, although it looks difficult to roll. The Germans seem to have made a study of such work as a sort of complement to forged ornamental work for which they are famous, and their exhibits in this line show to great advantage.

In the Russian section, near by, is an exhibit consisting of some hundreds of pieces in cast-iron, comprising a great variety of figures of men and animals, busts of celebrated persons, groups, etc., from one or two inches to fifteen inches, or more, in height. There are also card receivers, and a great number of similar pieces, exceedingly thin, perforated in intricate figures, altogether things of rare beauty and remarkable delicacy from that most common of metals—cast iron. I have never seen this exhibit equaled—or anything that could approach it in its way. It creates little wonder to note that a large part of the articles in this exhibit are marked "sold," the price being very moderate considering the quality of the work.

There is also in the Russian space an exhibit of electric casting and welding in which various articles in iron, steel, bronze, etc., are shown mended by the process, as for example a pulley, perhaps thirty inches in diameter, broken in several places, and then united. In the cast-iron pieces, as the pulley for example, there is a good deal of superfluous metal at the union of the broken parts, the work looking decidedly rough. In a steel shaft the mending is much neater, and the same is true of several brass and bronze pieces.

The M. C. Bullock Mfg. Co., of Chicago, Ill., make a good display of mining and prospecting machinery. There is one set of machinery that will bore a hole one mile in depth, small and large rock drills, their well-known diamond drills—hand and power, etc. There is also shown their new arrangement for removing the core in deep drilling, which is said to save just about one half the time of drilling. This device is very ingenious in construction, and, as shown, works smoothly and surely.

The Rand Drill Co, New York, show a compound air compressing plant, the compression being begun in one cylinder, and concluded in another. The engines are compound condensing Corliss, rated at 500 horse power. The air pump is driven by return rod and lever.

Near by is a compression plant by the Ingersoll-Sergeant Drill Co., of New York, the engine being quite similar to that of the Rand plant, an exhaust steam induction condenser being employed.

Both these firms have extensive exhibits of air compressors, rock drills, etc., in the Mining Building.

An exposition of power machines and machinery would be entirely incomplete without the "largest belt." This time the Page Belting Co., of Concord, N. H., supply what otherwise might have been a deficiency by exhibiting an oak tanned belt, three-ply, about five-eighths of an inch in thickness, eight and one half feet wide, 203 feet in length, and weighing 5,176½ pounds.

Chas. A. Schieren, of 47 Ferry street, New York, is scarcely behind with a belt eight feet wide, 200 feet long, and weighing 5,650 pounds. If not quite up to the mark in width, it is ahead in weight.

Both these belts are fine examples of workmanship, and the two firms named, as well as several others, show excellent belts of smaller dimensions, as well as various appliances in some way connected with the use and maintenance of belts in the transmission of power.

Otto Gehreckens, of Hamburg, exhibits a belt not so long and much thinner than those referred to above. If this belt fairly represents German practice in leather belts I should think it must be concluded that they are hardly up to the mark in belt transmission. This might be expected as other ways of transmission are largely in favor in most European countries while the leather belt is most in favor here. The result is that Americans know a good deal about belts and belt transmission, and not much about rope transmission. The outcome is that the making of leather belts is very much of a science here. The German belt, however, should be credited with the demoralizing effects of a sea voyage, which probably did not improve its appearance.

Volney W. Mason & Co., of Providence, R. I., have friction clutches as applied to various sizes of pulleys and for other purposes, and also their mechanism for hoisting, both of which are well known from their extended use. With the whip hoist a single lever controls the mechanism for hoisting, lowering and holding the load.

There is necessarily no connection between the qualities of goodness and greatness; but when utility is a consequence of size there is merit in the latter. Sometimes, however, people make large things just to show that it can be done, which is, perhaps, what induced the Simonds Mfg. Co., of Fitchburg, Mass., to exhibit a circular saw eleven feet in diameter. There is not, it is to be supposed, the remotest possibility of any one wanting such a saw, or of knowing what to do with it if he had it. But the company does show saws that are useful as well as do several others, notably Henry Disston & Sons, of Philadelphia, who make a fine display of saws in great variety.

The overhead track system of hoists, portable hoists, chain hoists, etc., by Maris & Beekley, of Philadelphia, suggests improvements that can be very readily and cheaply made in many machine shops whereby the handling of much work would be greatly facilitated, and where the use of large and expensive power traveling cranes is not desirable or practicable.

In addition to the exhibit of drop forgings by the Billings & Spencer Company, of Hartford, Conn., in Machinery Hall, to which reference has been previously made, this company has an exhibit of copper forgings used about dynamos in Electricity Building.

H.

High-speed and Cam-cutting Attachments to Milling Machine.

At the shops of the Mossberg Manufacturing Company at Attleboro, Mass., their work is the building of machinery and special appliances for manufacturing jewelers and a good deal of cam-cutting is done there as well as other milling that must be done with very small stem cutters. As usually happens where ingenious mechanics are employed upon special kinds of work, many special appliances and attachments have been devised here, among which are those illustrated herewith and which, we think, will prove of general interest. One of these is a high-speed attachment and the other a cam-cutting attachment, both these being shown in place upon a Brown & Sharpe universal milling machine having the overhanging arm, the arm being removed in this case, both because it is not needed for the work and because its room, or rather the outer support for it, is needed for a portion of the high-speed attachment.

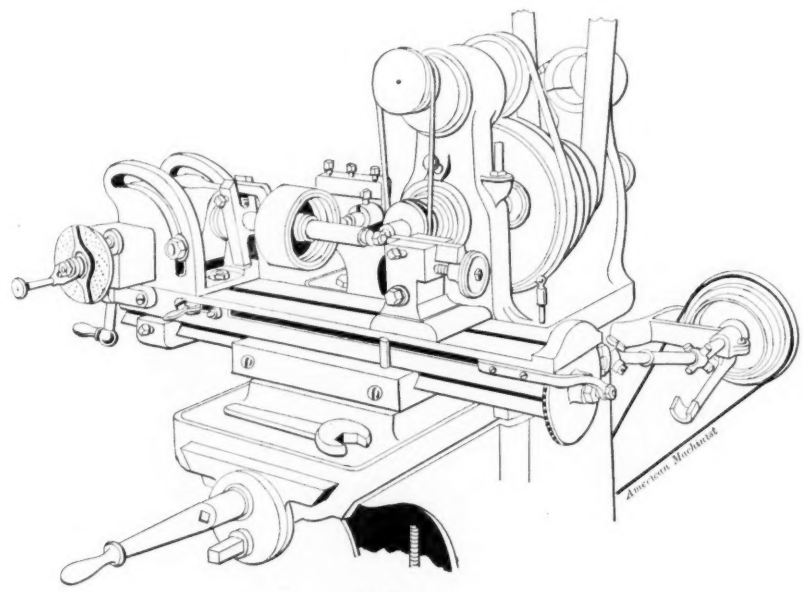


Fig. 1

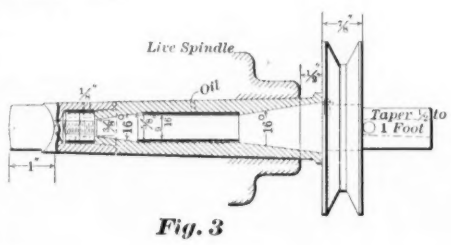


Fig. 3

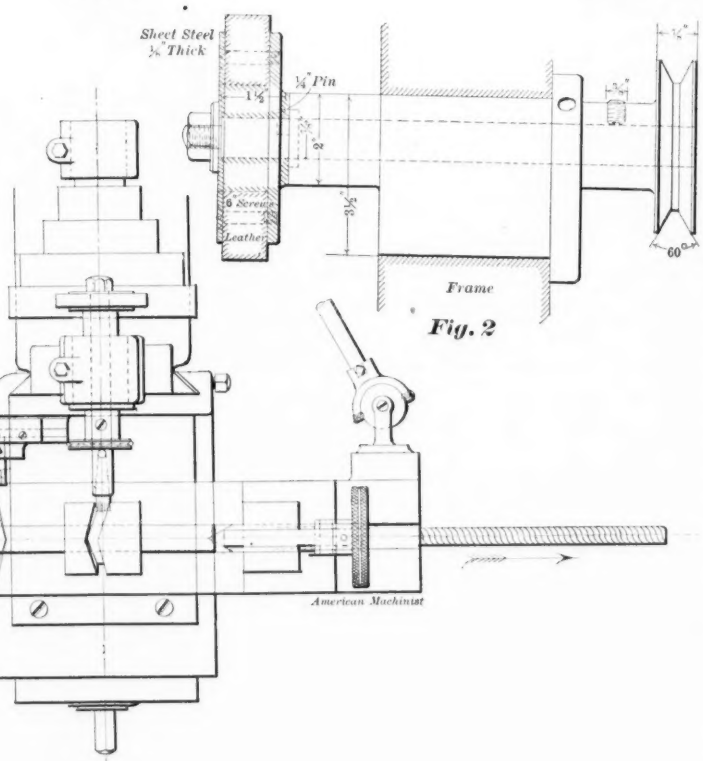


Fig. 4

HIGH-SPEED AND CAM-CUTTING ATTACHMENTS TO MILLING MACHINES.

This, as will be seen, is merely a piece of cast-iron turned to fit the hole, and having bored through it a hole which forms the bearing for a shaft, this shaft being driven from the cone pulley as shown and carrying at its outer end a grooved pulley from which a belt runs to a pulley below, this last-named pulley being upon the high-speed spindle. Working drawings of both these are reproduced at Figs. 2 and 3.

The reason for the construction of the pulley at the left of Fig. 2 is that it was at first intended to make this a friction wheel which would have left the large step of the cone pulley for the use of the regular belt upon it; but this slowest speed is not needed when the device is in use, and the fact that when driven as a friction wheel the motion is reversed proved disadvantageous for obvious reasons, and a belt is therefore used.

The high-speed spindle shown in place in Fig. 3 is fitted to a sleeve which in turn is fitted to the taper hole in the regular spindle, and the small spindle is bored to receive the shanks of the smallest size stem cutters which accompany the machine.

A plan view of the machine with both attachments in place is given at Fig. 4, where *A* is a small slide which carries a stud which may be fitted at the end with a roller the outside diameter of which equals the diameter of the cutter, though in the sketch it is shown larger, which would call for a form or guide *B* different in shape from that of the cam to be cut. This stud and roller are, of course, always used at the height of the spindle center and may be supported in any convenient manner, the method shown having the advantage of being substantial and not requiring any cutting or drilling of the machine. The horizontal adjustment of the guide stud enables the cutter to be brought to the desired point upon the blank, and the groove can be very readily enlarged slightly, taking a cut from either side by moving the slide and stud in the desired direction.

In many cases, perhaps a majority of cases where a universal machine is used, the cam-cutting attachment would be little used, but for reasons which have been frequently given, this or some equally good high-speed attachment is of very great utility where small stem cutters are used as it enables them to be run at a speed much more nearly approaching that at which they should run without increasing the rate of feed, which is just what is wanted.

There are in Russia about 7,000 miles of railroad belonging to the government, and 11,600 miles owned by companies.

The next place of meeting of the American Railway Master Mechanics' Association will be at Congress Hall, Saratoga Springs.

Steamship Lengthening.

It is not unusual nowadays to lengthen steamships; but doubtless some particulars of the alteration of this kind which the North German Lloyd steamer "Bayera" has lately undergone will not be without interest. This vessel having proved herself rather too small for the Eastern traffic, her owners decided to lengthen her by 50 feet —a work requiring six months to complete —and this has been successfully accomplished at the shipbuilding yard of Messrs. Blohm & Voss, at Hamburg. Being placed in dry dock, the steamer was severed amidships forward of the engine room, and the forepart drawn forward the required distance by hydraulic appliances. A whole compartment, 50 feet in length, was then built on between the two portions, and the necessary strengthening effected throughout. The "Bayera" is now 450 feet in length, and her carrying capacity for cargo has been increased by 2,400 cubic meters. The extra length has also added largely to the passenger accommodation. The first saloon—which has been entirely removed by the firm of F. C. Pfoff, of Berlin—is now placed on the upper deck, amidships, forward of the engines, and extends the whole width of the ship. All the public rooms have greatly gained in extent, and are placed in more advantageous positions. Some of the first class cabins are on the upper and some on the promenade decks. The latter has now a length of 200 feet, and is covered by a permanent awning. The dining saloon and the smoking-room for the second-class passengers are also on the upper deck, but placed aft, and the sleeping cabins formerly used by the first-class passengers are now made available for those in the second saloon, while various other improvements were also made possible by the alterations. It is stated that the "Bayera" is the first large ocean steamer in which such an important and extensive addition has been made. The "Bayera" on her recent trial trip attained a speed of about 15 knots.—*The Mechanical World.*

Some Railway Facts and Figures.

E. A. Mosely, in an address before the Railroad Trainmen's Convention at Boston, gave some statistics regarding the magnitude of railroad interests in this country. Some of his statements were as follows:

"To transact the business of the railways, there were required last year the services of 33,136 locomotives, of which 8,848 were employed in passenger service, 17,559 in freight service, and 6,729 in yard service and in service not specified. To perform the passenger traffic of this great country last year 28,876 cars were employed, and the freight surface of the country gave employment to 966,988; 36,901 cars were required in the service of the railways themselves.

"Putting these figures in a more concrete and definite form, the locomotives of the railways of the United States, if marshaled, with their tenders, into a single line, would make a train 357 miles long. With the passenger cars reported owned last year, we might make a train that would reach from Boston to within fifteen miles of Philadelphia.

"But the most wonderful figures are brought out by a similar arrangement of cars in freight service. Placing these cars together in a continuous train, it seems almost incredible that this train would be 7,028 miles long, but so the figures make it appear, and, allowing the distance from Boston to San Francisco to be 3,000 miles, our train of freight cars would reach from Boston to San Francisco, from San Francisco back to Boston, and from Boston again as far west as Chicago. What tonnage they would move at a single load I leave you to conceive if you can."

Finding Change Gears for Odd Pitches of Screws.

BY W. H. CROKER.

Under this heading there appeared in the April number of this journal, 1891, an interesting article from the pen of Mr. Geo. B. Grant, dealing with the subject in a masterly manner. The object of the present writer is to supplement a trifle to what has been given on the question, with a view of helping those readers who, like the writer, are slow at "figures," and who would prefer to substitute "lines" for most of the "ciphering."

The features of novelty in the method herewith presented (if novel they be) exist in making the *size* of the thread to be cut and the *size* of the thread of the lathe's lead-screw the basis of the gear ratio, expressed decimally; comparing the work thread with the lead-screw thread, in lieu of the more common method; and thence, onward, using a graphical process for determining what gears are suitable for the work in hand, and which the writer thinks affords a ready means of solving the possibilities of the gears belonging to the lathe used for doing the work.

Let us now proceed with an explanation of the working of the method, exemplified by an example: Required the proper pair of gears to be used in connection with a lathe having a lead-screw of eight threads

per inch, to produce a worm to fit a 14 diametral pitch gear, as near true as may be with the gears we have at hand, say with a Barnes lathe No. 5, its regular set of gears containing 16, 20, 24, 28, 30, 32, 36, 40, 44, 48 and 52 teeth. The preliminary step is to determine the decimal equivalent of the worm thread and lead screw thread. The former is .224″, the latter .125″. If we treat these fractions as abstract numbers they become simply 224 and 125, and can be used as forming the terms of the gear ratio; therefore if there were gears in our list answering to these figures the work could be done with them; but they are not to be found in the set. Under the circumstances the ordinary lathesman would, likely, divide by 10 and multiply the quotients by two, arriving at approximate gears having 45 and 25 teeth, the resulting work having an error of .0045″ per inch. As these gears are not available in our set, we will not continue the search for other ones on this line, but go on with the graphic part of our method.

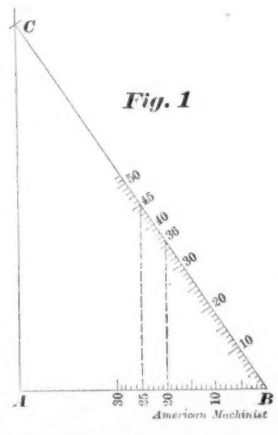


Fig. 1

Referring to Fig. 1, make $A\ B$ and $B\ C$ proportionate in length to the ratio numbers (224 and 125). This may be arranged for by dividing the numbers by 10 = 12.5 and 22.4. From A erect a perpendicular $A\ C$ to $A\ B$, produced. Make $A\ B = 12.5''$, and on B as center, with 22.4″ as radius describe an arc cutting $A\ C$ in C, and join $B\ C$. The construction is thus arranged so as to allow of the ready use of a T-square, as the sides forming the right angle are supposed to be parallel with corresponding sides of a drawing board, thus avoiding the necessity of using a set-square. From B, along $B\ A$ and $B\ C$, lay off a scale of convenient equal divisions, say in quarter-inch spaces, and number as shown, commencing with the smallest gear (16) and ending with largest (52) as shown. If, now, the T-square is made to traverse the triangle with its blade parallel with $A\ C$ from scale to scale, and noting where the blade coincides with a division on each side (as shown by dotted lines), said coincidence will be found to closely take place at divisions 20 and 36, and as these numbers are in the set of change gears, such gears are right for the work in hand. Pursuing the investigation further, we will find another close coincidence at divisions 25 and 45, as shown, and in agreement with the trial work of the supposed lathesman mentioned above.

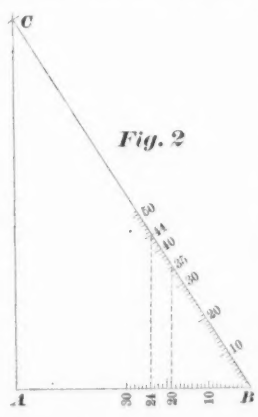


Fig. 2

Referring to Mr. Grant's article, the problem there set was to find the proper gears to produce a screw that would move its nut 12.37″ in 47 turns, with a lead-screw having seven threads per inch. To solve this problem by the graphic method, first find the decimal equivalent of the lead-screw thread = .14285″, = one term of the required ratio, and for the other term divide 12.37″ by 47, = .26319″. With these figures as a basis construct the triangle of Fig. 2, making $A\ B$ = say, 14.285, and $B\ C$ = 26.319″, arranging suitable scales as shown (and as explained at Fig 1). Applying the T square, as before, the blade will coincide with division 19 on $B\ A$ and 35 on $B\ C$, and these gears are the proper ones to use, as given by Mr. Grant. Still the gears are not in the set we have supposed as available, so we will carry on the search for the best pair to use belonging to the set, and find that the nearest to our requirements falls to 24 on $A\ B$, and 44 on $B\ C$. These gears being on hand we can do the work with an error of .228 part of a turn, being a much larger error than perhaps would be allowed; but it is a satisfaction to be able readily to know the best that can be done with the gears at hand.

Arbor Press.

The accompanying illustration is of a machine designed to facilitate the operation of putting lathe work onto and removing it from arbors. Its principal advantages over the usual appliances and methods seem to be that it can always be readily found, that arbors are driven square and true, and the centers are not filled with fragments of copper, babbitt or other foreign matter that must be carefully removed before the arbor can be put upon the centers.

As will be seen, the machine is a very simple affair, the work resting upon a plate which revolves to bring any one of the various sized notches under the ram. The various sized notches are, of course, for various sized arbors.

The lower extremity of the ram is hardened steel; the rack teeth upon it are cut from the solid steel, and the pinion is also of steel. The lever is balanced, and may be used in any convenient position. The machine is made in three sizes, suitable for work from 10″ to 18″ diameter, by the Fox Machine Co., Grand Rapids, Mich.

LETTERS FROM PRACTICAL MEN.

The Limitation of Engine Speed.

Editor American Machinist:

An abstract of a paper which was presented at the World's Engineering Congress was published in the AMERICAN MACHINIST some time ago, and commented on later by "Bell Crank."*

Mr. Porter's mild criticism of the present engineering practice, and coming as it does from such high authority, demands consideration from the builders of the so-called high-speed engine. It is only too true as Mr. Porter states in his admirable paper that one of the chief causes why the high rotative speed engine of the past and present time has not proved to be as economical in the use of steam as its slower speed rivals is on account of the large waste room required for proper steam distribution. Waste room coupled together with insufficient port area, causing the initial steam to be wire-drawn at cut-off, is, in the writer's estimation, the sole and only reason that the high-speed engine is such a steam eating flyer as it in reality is.

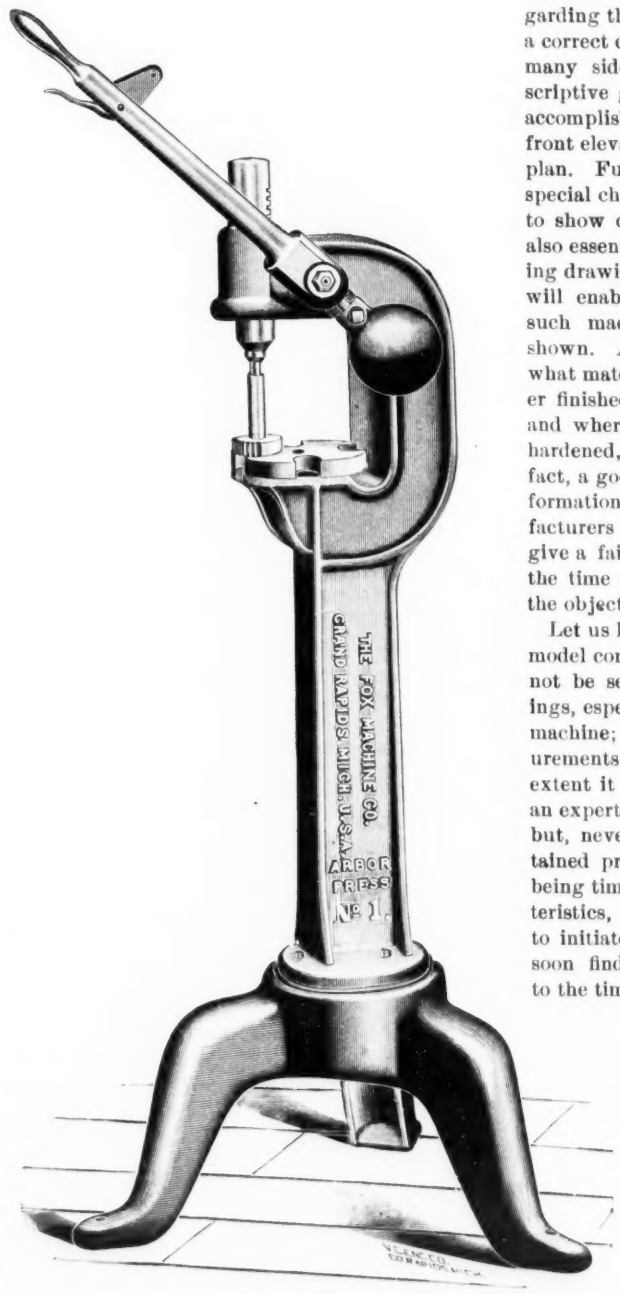
On investigating the matter carefully we are met with the objection that in the high speed class of engines large waste room becomes a necessary evil in order to prevent break-downs from water in the cylinder. The fact of the matter is contrary to the above theory; it is a well-known fact that excessive clearance may increase the danger of a break-down instead of diminishing it.

Right here one finds the situation rather amusing. The engine builder in his endeavor to demonstrate to the prospective purchaser that large clearance is such a necessity in order to prevent the piston from letting daylight in the cylinder in case water should come over from the boiler seems totally unconscious of the fact that he has furnished his engine with a first-class and certainly a very effective cylinder smasher, namely, the solid piston valve; or, perhaps, it may be a flat valve with a ridge and pressure plate.

It would be much better if engine builders would reduce the clearance space from eight or ten per cent. as is the common practice now, to less than two per cent., which can be done just as easily with a high-speed engine as it can with a slow-speed type.

* See "Compression as a Factor in Steam Engine Economy," by Frank H. Hall, AMERICAN MACHINIST, August 24, 1893.

"Bell Crank" makes the assertion that it can be theoretically, and has been established by experience, that the clearance space in a non-condensing engine can be filled by compression, so that the waste room is not the cause of any loss of steam. He further states that all the force exerted in compressing the steam to fill the waste room is reacted on the piston. "Bell Crank" takes a rather pessimistic view of the matter. He surely must be aware of the fact that such a fortunate conjunction of circumstances rarely happens, in practice never. It only occurs under one condition, namely, when the steam is expanded down to the back pressure line in the cylinder, and if the exhaust steam be so compressed into the clearance space on the return stroke that the final pressure there is equal to the initial pressure for admission, then the efficiency of the steam in the cylinder becomes the same as if there were no clearance or compression at all. But whenever there is any free expansion, that is, a fall of pressure, from the final pressure of expansion to back pressure line, the opposing work of compressing a sufficient quantity of steam to fill the clearance space with steam of initial pressure, starting from a lower pressure, is so much increased in consequence that the net efficiency of the steam is reduced by it.



ARBOR PRESS.

It has been proven, and the statements can be verified again, that a greater degree of efficiency can be obtained by inclosing a less quantity of exhaust steam for compression than would be necessary to fill the clearance space with steam of initial pressure when the steam is not carried down by expansion to the back pressure line.

I will state that it has been shown that high piston or rotative speed is productive of economy, and there is no material reason why the high-speed engine cannot be made as economical in the use of steam as the slow-speed Corliss type.

Insufficient port area and valve travel is another detriment to the economical working of the modern single-valve automatic high-speed engine.

A. F. KEFFLO.

Carroll, Iowa.

Drawing vs. Models.

Editor American Machinist:

"Drawings are good," says a writer on machine shop practice, "but models are better. If only one of these elements can be had, let it be models of the parts to be manufactured." It seems to me that this subject is worth discussing, inasmuch as it is one of importance, and besides, mechanics ought to have the benefit of the experience of other men. I hope many of the craft will give their opinions.

First of all let us look at both, a drawing and a model, and define what they are, or ought to be. A working drawing, as used in machine shops and factories, contains, or should contain, all necessary data regarding the object it represents, viz., a correct delineation as seen from as many sides as possible, and as descriptive geometry teaches, it is best accomplished in three views, *i. e.*, a front elevation, a side elevation and a plan. Furthermore, if there are any special characteristics, it is advisable to show one or more sections; it is also essential to give on a good working drawing all measurements which will enable a mechanic to produce such machine or machine part as shown. A drawing must also state what material should be used, whether finished and hardened, if of steel, and where it should be finished and hardened, and to what extent. In fact, a good drawing contains all information necessary to enable manufacturers and master mechanics to give a fair estimate of the cost and the time that is necessary to produce the object in question.

Let us look at a model. It is true a model contains such elements as cannot be seen at one glance on drawings, especially if it be a complicated machine; it also contains all its measurements in itself. It shows to what extent it is finished, and may enable an expert to judge the material used, but, nevertheless, all these self-contained properties are very far from being time and labor saving characteristics, and establishments trying to initiate this state of affairs would soon find that they have gone back to the times in which they had to do without the advantages of drawings.

Nowadays, when we are accustomed to work close, the limit of exactness very often being .00025 of an inch, it is self-evident that it would consume too much time, and since the use of models would insure anything but exactness, the consequence would be that the machine or machine part built or manufactured would not satisfy the conditions at all.

But models are good in this sense: When drawings have been prepared, and it is a question to produce in large quantities, then, and only then, before going to the expense of making special tools, make a model that will satisfy the demand, and let it *guide* you in getting up your jigs, etc., after which this model may serve in a showcase. For the manufacturing of useful things, especially machinery, we need drawings which are legible, and men who know how to translate them.

Of course, if people in responsible positions have no idea what a drawing is, merely considering it a picture, and I fear there are many such men, and when they actually convert a drawing office into a picture gallery, then one should not be surprised when "drawings are good, but models are better."

Of course, if people, who profess to be experts in the art of manufacture, can pronounce that the finishing of certain places on an object is not considered in a drawing office, as happened to the writer lately, then no doubt drawings are a farce. But it must be a golden prosperity that will not only stand the treatment where the good talker gets the best of the good worker—a prosperity that will stand the use of models instead of drawings. E. LAWRENZ.

"That New Packing Ring."

Editor American Machinist:

I have read Mr. Frank Richards' letter in the AMERICAN MACHINIST of October 12th headed as above, criticising my packing ring appearing in your issue of September 7th. I think Mr. Richards has some mistaken ideas in regard to my ring, due no doubt to the brevity of the description. Others have, and I hope I am doing Mr. R. no injustice by supposing that he has also. I beg permission to re-describe it.

If we take a round ring and cut and close it as in Fig. 1,* we shall have the diametrical shape of the bore of a cylinder that a round ring will fit with a close approximation to perfection, simply because that is the shape of a round cast-iron ring of uniform section when cut and sprung together and held there by a flexible band. For many obvious reasons we do not want cylinders bored the shape of Fig. 1, but what we do want is a ring having such a diametrical shape that when sprung into a round cylinder it will fit it equally as well as a round ring will fit an oval cylinder. The question now arises, what should be the shape of such a ring? It "happened to strike me" that an expanded ring giving the shape of Fig. 2 would do this, and I have had no reason so far to change my mind. Of course it is not expected that cast-iron, or in fact any material is uniform and will always give the same results; we can only average the results of many experiments; for instance, the modulus of elasticity for cast-iron varies (according to Trautwine) from 12,000,000 pounds to 23,000,000 pounds per square inch, which means that a given load will deflect some cast iron beams nearly twice as much as others; hence the necessity of continually testing the product. I hope when Mr. R. takes up this interesting and important subject again he will give us the result of his experiments in this line. Prove to us by both figures and philosophy that "the thing demonstrates itself that neither of the methods employed for applying a uniform pressure and consequently a uniform bending force all around the ring, accomplishes the result intended or the ring would still be round." I have always thought there was a uniform pressure inside a boiler when there was any pressure at all, also that when the pressure gets too great, if a longitudinal seam lets go that the shell would be neither still nor round, but an active "aero-plane." If we were to bend up a ring of boiler steel, leave the seam unriveted and then apply an internal pressure that would at all times act at right angles to the neutral surface of the sheet, it would be only a question of pressure and time till the sheet was "flat" provided that it rested on a plane surface at the start.

I think from what has just been said that Mr. R. will see that if an internal pressure be applied to a round packing ring after it has been cut that it will *not be round.*

As illustrating the theory on which my packing ring is based we will suppose it be required that a straight beam supported at each end and loaded in the middle shall deflect a given amount. It is also required that the beam shall be straight when loaded, as in Fig. 5. The question is, what shall be the shape of the beam? Now the editors of the AMERICAN MACHINIST and many of their readers can answer this question by mathematics, but I think all will say the calculation should be verified by experiment, so, for a small job like this, the calculation can be dispensed with and depend wholly on the experiments. Therefore we will load a straight beam and note the elastic curve, *i. e.*, we make a pattern just that shape. The curve is represented in Fig. 6. Now I think that when we get a beam cast from this pattern, and invert it on the support, and put on the load, that the beam will be nearly straight. (As regards this, much will depend on the skill in the foundry.) As a proof, suppose the beam is loaded as in Fig. 7; there can be no doubt but the amount of deflection will be the same as in Fig. 6, the only difference will be in the direction, one being up, the other down. We now add another load W_1, and of course the beam must come to its original shape (straight) for there is practically no load upon it, proving conclusively that a load that will deflect a straight beam will also straighten a deflected one. The analogy between a beam and a packing ring will be readily seen if we consider a packing ring a circular beam uniformly loaded and supported by its elasticity. In the ring as in the beam, a given deflection is required, the only difference is that the beam when deflected shall be straight, while the ring is to be round.

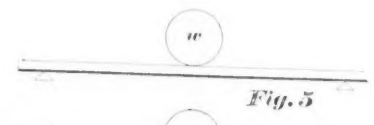


Fig. 5

Fig. 6

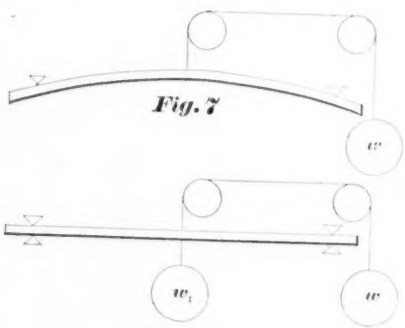


Fig. 7

Fig. 8

Fig. 9

Fig 9 represents a round ring that has been deflected by the load, that is represented by the arrow heads. From this ring in this shape we make a pattern and cast a ring as we did with the beam in Fig. 6. This cast ring we load as in Fig. 10 with sufficient force (as shown by the arrow heads) to close the ring at the cut. Will Mr. Richards tell us why such a ring, cast from such a pattern and closed at the cut, as shown, ought not to be round?

Fig. 11 was made from a 32-inch packing ring that had been cast from a pattern (with a slight modification) that had been made as just described. The section of the ring is 1 inch square. The spring at the cut is 1¼-inches, the cut is at *A*. The amount the ring is out of round is shown by the circle drawn just inside the short arcs of circles describing the shape of the ring. It will be noticed that the ring is too stiff at *B* opposite the cut. It is thought that as the ring wears this extra stiffness will be required to preserve the "rotundity" of the ring, and is not to be considered an objection as the pattern was made to produce it. Fig. 11 was made from a casting in the rough. It was closed at the cut and held in that position by a copper wire while the figure was outlined. When held closed by a force equal and opposite to that employed in making the pattern ring it does not vary $\frac{1}{32}$ inch from being round.

As regards prices I will say that the value of a packing ring ought not to be measured by its cost, for if steam is worth anything a cheap ring may be very expensive, and *vice versa*. My first object has been to make a ring as nearly steam tight and frictionless as possible, then simple and durable, and lastly, that could be sold at a moderate price. If I have accomplished this, it leaves nothing further to be asked for so far as piston packing is concerned that I know of. I think Mr. R. is also mistaken in the cost of my ring. If he or any one else will favor me with an order giving size of cylinder and grooves in piston I will give prices, and if the rings are not satisfactory they are to be returned at my expense.

I have had a set of packing, made on the principle described, in a 32x60 inch engine in the Brown-Bonnell Iron Co's. mill, running double time for 10 months giving the very best satisfaction. J. H. DUNBAR.

Youngstown, O.

Prof. Reuleaux's Position.

Editor American Machinist:

Referring to your editorial in the AMERICAN MACHINIST for October 26th, about Professor Reuleaux's address at the Engineering Congress at Chicago, there is not the slightest doubt that he meant just what he said, and I think your editorial emphasizes just what he did say. In conversation with the Professor at that time, and also subsequently—in fact since his receipt of the misinterpretation of his words which had appeared in the German papers—he assured me that he meant what he said in that the American workmen and machinists were ahead of those of Europe *in the use of instruments of precision*, and especially of appliances for measuring with a high degree of exactitude. You say in your editorial: "We are not of those who believe that we Americans are, and of necessity must be, superior in every respect as mechanics to the mechanics found in foreign countries," but unfortunately this is just what the German papers made the Professor say, and it is this which he is most desirous that the American papers should correct for him. He paid especial tribute to the superiority of American mechanics in *the one point of the use of exact measuring appliances*, and the German papers construed this to mean an assertion on his part that the American workmen were superior in every respect. His position in this matter is especially peculiar from the fact that when he was juror at the Centennial Exposition of 1876 he criticised the products of the German establishments unmercifully—and with justice—as their exhibits were decidedly inferior at that time to those of other countries. The German exhibits at Chicago, however, fully redeemed the position of their country and placed them in the van, and it is only natural that the man who did more than any other individual to advance the cause of machine designing and construction in Germany should not be construed as condemning and criticising the very establishments which have done so much to profit by his former criticism.

I know that Professor Reuleaux will be glad to see that the AMERICAN MACHINIST understands his position, and I am only desirous of emphasizing in your columns his position as he himself expressed it to me a few days before he sailed for Germany.

H. H. SUPLEE.

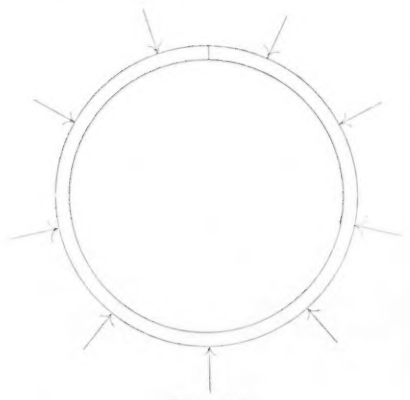


Fig. 10

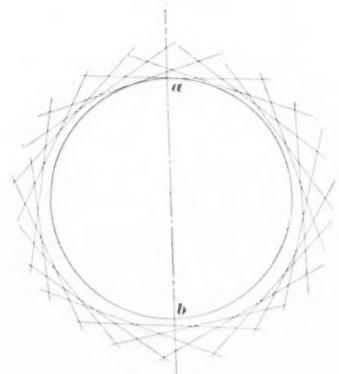


Fig. 11

The Chicago Exhibition.

Editor American Machinist:

In a ramble through back numbers yesterday, I ran overt his. Don't you think you ought to patch it with Director-General Davis? He has turned out a pretty big show, and made it pay.

O. J. EDWARDS.

The item referred to by Mr. Edwards appeared in our issue of January 29, 1891, and is as follows:

Director-General Davis, of the Columbian Exposition, is doing some good work for the great Fair, and he is also doing some unseemly talking on the subject that does not help the project a bit. The declaration that "It will be the greatest world's exposition ever held" had better been left unmade for a year or two at least. People are not enthused in these times by such talk; on the other hand it is likely to have a contrary effect. Quiet work, and a plain statement of what has been accomplished is what counts. We hope it will be the greatest fair ever held, but talk will not make it so.

Power Transmission.

Editor American Machinist:

A few weeks ago you published a sketch of an old device for churning by water.

There was just the same thing built in the village of Watervale, town of Pompey, county of Onondaga, N. Y., by a Mr. Case for Charles Carr, his wife says, 56 years ago or in the year 1837. W. A. SWEET.

Milling Machine Feeds.

Editor American Machinist:

I was much pleased to see in your paper two articles about milling on pages 6 and 7, October 26, 1893. I have had a little experience with the milling machine, in fact I believe sometimes I am a crank on milling; however, I wish to say that the article by "A Mechanic" is quite true, and I believe that the time is near at hand when the milling cutter will be run with the work. There are now several good methods of taking care of backlash in the screw as well as in rack and pinion. In regard to what C. H. Beach says, I have had the same experience as he a number of years ago, and I believe the best way to cut thin slots in cylinders is to run with the work or feed. There is nothing new about running same as above, it is very old; however, we all agree that there is something new in milling large work this way. In order to get good results milling the "new way" the machine must be quite rigid, and with proper arrangements for taking care of backlash. When the two features just mentioned are complete we can mill cast-iron 5" wide, 2¼" thick, 10" long, *in half the time he can the old way on the same machine.* I have milled several hundred of these pieces, cutting one side and both edges at same time, feeding about 6 inches per minute. Speed of cutter 33 feet per minute. Cutter will *keep sharp longer* running the *new way.* However, I believe a great deal of the good is obtained by the cutter holding work and platen down solid. If your readers will just consider a moment they will see that by the old way of running cutter the platen is

* For Figs. 1, 2 and 3 see AMERICAN MACHINIST of September 7th.

picked up and dropped hundreds of times even in milling a short piece. They will also notice that some of the builders of milling machines make quite a strong bed and platen and then spoil both by adding a very thin gib to hold platen down.

After 21 years' experience on milling machines as apprentice, about two as a regular workman, the remainder as contractor, foreman, and finally assistant superintendent, I want to say that the milling machine is only commencing to find its place. I also want to say that any man skilled in the art of milling and in milling cutters and fixtures can, in such places as locomotive shops and hundreds of other machine shops, take jobs by the hundred off our most improved planers and effect a saving of at least 25 to 50 per cent.

I also wish to say that my experience has convinced me that the time is come for *special* machines for milling, the designer keeping in mind all the time the particular piece to be milled. J. A. McGregor.

Tricks with Taps.

By Frank Richards.

I lately dropped in to see our genial friends—they are too modest to pass any high-pressure adjectives—the editors of the American Machinist and Mr. Fred J. Miller showed me a tap forwarded some time ago by the Cleveland Twist Drill Company. The tap was a long tap about the style of a common machine tap, and $1\frac{1}{2}''$ in diameter, 16 threads to the inch, and had five flutes or rows of cutting teeth. Upon the tap were two nuts that had been tapped by it. One of the nuts was tapped correctly with a single thread $\frac{1}{16}''$ pitch, and it calls for no special remark. With the other nut for a text there is much that may be said, but whether to our profit or not the preacher cannot even conjecture. In this nut the apparent measure of the thread was the same as in the first one, $\frac{1}{16}''$, but the actual pitch, or the distance traversed parallel to the axis of the tap for each revolution, was much greater than in the first nut. The nut had evidently been forced upon the revolving tap too rapidly, and the tap instead of cutting a single thread, as it should have done, had cut several threads at once, or had made what we commonly call a multiple thread. Taps have a trick of doing this when they are overcrowded. I have always had a feeling about me that machine tools are more or less human, or at least have some human traits, bad ones if not good ones. Now when a tap under excessive pressure and provocation goes and cuts a multiple thread when it should have cut a single thread, what is the thread that it will naturally cut under the circumstances, and why? This question was brought to the attention of the readers of the American Machinist several years ago by one Chordal, a primeval contributor who "in his day was reckoned good," and I had the pleasure of offering an explanation of the case. It has come to my knowledge that the explanation then given was not as clear and intelligible as it might have been, or at least it was not so fortified as to make misinterpretation, which is defeat, impossible. The possibilities of misunderstanding are great, because while there is but one right way of doing a thing or of understanding a thing there are many wrong ways, and much ingenuity is wasted in exploring the devious paths. It may not be such a waste after all. Doubtless we should all be thankful for the waste, for if human invention had not such means of relief—in addition to those provided by Mr. Leicester Allen—its accumulation would be dangerous. Bnt since this tap case has come up I am tempted to try my hand again at an explanation, although it is always easier for me to find the faults in another's work, and to try to put improvements upon it.

I remember that once when I was a foreman in Troy one of my boys was tapping some cast-iron nuts with a tap that had but three flutes (I had nothing to do with the making of the tap), and he brought me a nut just tapped, with, "Say, boss, that there tap has been and spoiled this here nut, and it won't screw onto the hanger. There's three threads into it instead of one. Every one of them rows of teeth onto the tap has been and cut a thread for itself." Then I told him to just count the threads again, which he did, and he had to exclaim, "Why, by jiminy, there's four threads into it," and I had to tell him that there couldn't possibly have been three threads in it if cut with a tap that had three flutes. But lots of good machinists have made the same mistake, and many to day would tell you that this five-fluted tap, that I set out to talk about, should, when it ran away with itself, have cut five threads in the nut, while as an actual fact it cut six threads.

Now we will try to do a little experimental tapping with this recalcitrant tap, and we will assume that the nut is stationary and that the tap does all the movement both of revolution and of advance. When tapping correctly and cutting a single thread, $\frac{1}{16}''$ pitch, any tooth of the tap, and consequently the whole tap, at each complete revolution advances axially or lengthwise, $\frac{1}{16}''$, and, starting from any point of the revolution, any tooth to move from its own place to the place then occupied by the tooth in front of it, or to make one-fifth of a revolution, must, at the same time, advance axially one-fifth of $\frac{1}{16}''$, or $\frac{1}{80}''$. Consequently for the whole tap to turn one-fifth of a revolution and at the same time to advance axially $\frac{1}{80}''$, any tooth upon the tap to be able to track exactly into the path of the tooth that went before it must be $\frac{1}{80}''$ farther back lengthwise of the tap, or axially, than the tooth that went before it. The next tooth must also be $\frac{1}{80}''$ behind this one, and so on, for every tooth around and around the tap, and that is precisely how they are.

We may now try to cut with the same tap a five fold thread in the nut, or a thread of the same apparent dimensions as before, $\frac{1}{16}''$, axially from the point of one thread to the point of the next one, but each thread advancing axially $\frac{5}{16}''$ at each revolution. In this case as one thread occupies but $\frac{1}{16}''$ lengthwise, while it advances $\frac{5}{16}''$, there is thus left $\frac{4}{16}''$ to be occupied by four other similar threads, or five threads in all. Starting now with any tooth of the tap from any fixed point around the nut and moving one-fifth of a revolution and advancing at the rate of $\frac{5}{16}''$ for the whole revolution, or $\frac{1}{16}''$ for the one-fifth of a revolution, the following tooth should be precisely $\frac{1}{16}''$ axially behind the one that has already cut so that it may follow in the same groove. To be $\frac{1}{16}''$ axially behind the tooth of the preceding row means, as the teeth are $\frac{1}{16}''$ apart upon the row, that the teeth upon each row must be axially coincident with those of each other row, or that the cutting teeth must be arranged, not spirally, but in independent parallel circles around the tap, and only this style of a tap could cut five threads with five flutes, and it is this kind of a tap that one has, unconsciously perhaps, in his mind when he thinks he can do it.

To go on with our tapping with the actual tap, still trying to cut the five threads, we want the next tooth upon the tap, as we have said, $\frac{1}{16}''$ axially behind the tooth that has already cut. But as we saw before, the next tooth upon the tap around backwards is not $\frac{1}{16}''$ axially behind the other, but only $\frac{1}{80}''$ behind, or taking the next tooth of the same row, which is really the one that is now to do the cutting, it is $\frac{1}{80}'' + \frac{1}{16}''$ behind, or $\frac{6}{80}''$ in all; and if the tap is to do its cutting with these teeth following in the track of each other, it must advance axially $\frac{6}{80}''$ for each one-fifth of a revolution, or $\frac{6}{16}''$ for each revolution, or it must traverse axially at each revolution a space just sufficient for six threads, and will of course cut the six threads, just as we find them in the nut.

It is, of course, understood by every practical man that this tap when "cutting" in this way does not cut a smooth or perfect thread. We may assume that the cutting teeth are very thin, and even then the back of the tooth drags and scrapes and mutilates the thread so that it is good for nothing that I know of except to be talked about, and if that is goodness then this world is not so bad a world, after all.

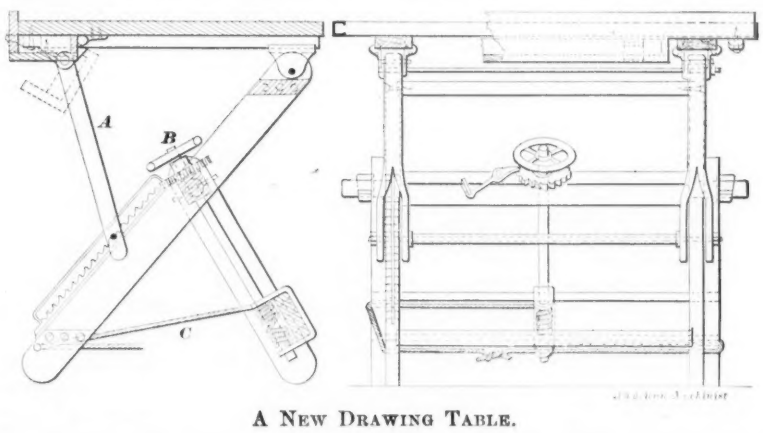
Assuming that the rows of cutting teeth upon our tap are as thin as possible, and with cutting faces upon both sides, we can now take the same tap, and, turning it the other way, try to tap a nut with a left-handed thread, and see what will be the pitch and the number of threads obtained. Suppose that we try to tap a five-fold thread left-handed the same as we tried to do the other way. Starting as before with any cutting tooth and going one-fifth of a revolution and advancing axially $\frac{1}{16}''$, the following tooth should be axially $\frac{1}{16}''$ benind this one to be able to follow it precisely. But the next tooth is not $\frac{1}{16}''$ behind. Remembering that we are now turning a right-hand tap backward, the following tooth is $\frac{1}{80}''$ ahead of the cutting tooth instead of behind it. The next tooth on the same row is the width of the thread or $\frac{1}{16}''$ farther back, which is $\frac{1}{16}'' - \frac{1}{80}'' = \frac{4}{80}''$ behind the cutting tooth. Consequently it can be advanced axially only $\frac{4}{80}''$ for each one-fifth of a revolution, or $\frac{4}{16}''$ for each revolution: it will traverse lengthwise a space only sufficient for four threads, and it will actually cut only four threads instead of five, and the actual pitch in this case will be $\frac{4}{16}''$. When cutting left-handed, this right-hand tap will cut one thread less than the number of flutes, and when cutting right-handed it will cut one thread more than the number of flutes.

Theoretically the same principle may be extended indefinitely, and will hold good as far as you choose to go. If we advance the tap axially $\frac{1}{16}''$ more than before for each one fifth of a revolution, so that the next thread on the flute will be able to follow the cut, or $\frac{5}{16}''$ more for the whole revolution, we then cut five threads more than under the previous conditions, whether cutting right-hand or left-hand. The number of threads cut right-handed in this case would be eleven, and the number cut left-handed would be nine. With a right-hand tap with two flutes, the possible right-hand threads would be, 1, 3, 5, 7, 9, etc., and in this case the possible left-hand threads would be the same, 1, 3, 5, 7, 9, etc. You can make a tap with two flutes, then, that will cut the same threads single or multiple, and equally well either right-handed or left-handed, but very badly in either direction. A tap with three flutes will cut right-handed, 1, 4, 7, 10, etc., and left-handed it will cut 2, 5, 8, 11, etc. With four flutes the number of threads will be, 1, 5, 9, 13, etc., and 3, 7, 11, etc.

And you can't cut any other threads than these. That is, you can't and you can. You can't cut threads of the normal size. If by any hocus-pocus we could smuggle our tap bodily into the nut before doing any cutting, and then should revolve it without permitting any movement lengthwise, we would cut a series of grooves of triangular section—with a V-thread tap, of course—the base of each triangle measuring $\frac{1}{16}'' \div 5 = \frac{1}{80}''$. If we should undertake to cut any whole number of threads other than a multiple of the number of flutes plus one if right-handed, or minus one if left-handed, we would get these diminutive threads instead of those of normal size. The pitch or longitudinal movement would be correct, but instead of the expected number of threads we would have that number multiplied by the number of flutes.

To show this, let us try to cut a double thread. We start the tap revolving and give it the necessary advance of $\frac{2}{16}''$ for a revolution or $\frac{2}{80}''$ for one fifth of a revolution. Then having made a cut with one tooth, when the next tooth comes along, it being $\frac{1}{80}''$ behind by its position upon the tap, and being advanced during its travel of one-fifth of a revolution, $\frac{2}{80}''$ by the longitudinal movement of the tap, it is really $\frac{1}{80}''$ ahead of its required position, and it goes along cutting an independent groove parallel with the preceding one, but $\frac{1}{80}''$ in advance of it. The next tooth cuts another groove $\frac{1}{80}''$ in advance of this, and so on until the whole surface is ploughed over with these $\frac{1}{80}''$ furrows; and so on, and so on.

One mustn't be too funny if he wants any repute for wisdom, and one mustn't be too speculative if he wants to be considered practical. All this about the taps doubtless has its practical bearing when we find where it fits. I wouldn't have gone into it at this time only that I was challenged by an esteemed friend to do so. Never go back on your friends!



A New Drawing Table.

A New Drawing Table.

With this we give an illustration of a new drawing table invented by G. P. Wern. Its construction is comparatively light and simple, and draftsmen will find it to be a very convenient table. By turning the wheel *B* attached to the shaft as shown, the cord *C* is wound or unwound on this shaft, by which the distance between the points of support is increased or decreased and the board lowered or raised. The points of supports always adjust themselves to an uneven floor, thereby securing absolute steadiness. The board can be tilted to any convenient angle by simply moving the lower end of the brace *A* along the rack. The end of this brace is attached to treadle so that the tilting is done by foot. A swinging shelf is attached to the rear edge of the board, which can always be kept in a horizontal position for holding the instruments. The table can be readily folded into a small compass for storing or transportation.

These tables are manufactured by A. Benoit, 146 Fulton street, New York.

It is rather apparent that the immigration laws of the country will soon be made very much more stringent than they are at present, one of the requirements quite probably being that immigrants shall be able to read and write in the language of the country from which they come. The change likely to be made is the result of the unloading here from European countries of a class of emigrants in every way undesirable, and the efforts of many manufacturers to fill their works with "cheap labor."

It is announced that John Fritz, whose mechanical genius has built up the Bethlehem Iron Works, and some account of whose history we gave in our issue of October 6, 1892, has resigned his position there as consulting engineer, and is no longer connected with the company.

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The World's Columbian Exposition.

The World's Fair of 1893 has passed into history, and it must be very gratifying to every American to know that it has been successful both in character and financially, far beyond general expectations, even amongst its warmest friends. This success has been attained, too, in spite of what have at times seemed almost insurmountable obstacles, and it must be conceded that those upon whom the work of creating and managing the affair has devolved, deserve the greatest credit.

As our readers know, we do not consider that the Fair has been faultless; probably no exhibition ever was or ever will be without its faults, but the success attained proves that its merits practically concealed its faults.

It is too common to award credit for the success of the Fair solely to those directly connected with it. It should, however, be remembered that every inventor, mechanic or workman whose work was represented there contributed his share, and that the Exhibition was an exposition of the present attainment of the world's workers—those who do something that is of some use to others.

The educational influence of the Fair will doubtless be of the greatest value, for thousands have visited it who seldom leave home, and who give themselves little opportunity for the cultivation of that broad-mindedness which can be attained only by the knowledge of what other people in other walks of life and in other lands are thinking and doing. Even the Midway Plaisance, popularly regarded as a place in which to merely have fun and spend money, was undoubtedly of very great educational value to the multitudes who there came as near as they can ever hope to come to a foreign tour, and who were at the same time serious-minded enough to realize that the Plaisance was much more than a place of mere idle amusement.

One of the most regrettable features of the case is the fact that the course pursued by the railroads prevented school teachers in any large numbers from attending. During the entire vacation term when teachers could have gone to Chicago, the rates for getting there were prohibitive for most teachers, the reductions going into effect only when the summer vacations were over and teachers had to resume their work, a work which consists too largely in teaching things from books and too little from actual experience, and from things seen and studied objectively by the teacher.

The murder of Mayor Harrison, of Chicago, by a hare-brained crank just as the Exposition was closing, though it probably had little or no direct connection with the Fair, yet will always be closely associated with the history of the enterprise, especially as it served to change entirely the character of the closing scenes.

Unfair Criticisms.

We publish in another column a letter from Mr. H. H. Suplee which makes plain the fact that in Germany, as elsewhere, those who propose to discuss or to criticise what another has said, are too apt to pay insufficient attention to what has actually been said, and to base their criticism or discussion upon something not said, and plainly not intended to be said. This unfairness and injustice is usually not intentional, but is the result of carelessness or lack of willingness to take sufficient pains to ascertain just what was actually said, and its exact meaning. Where a speaker or writer does not himself take care to express just what he means to convey in unmistakable language, he has no right to complain if he is misunderstood; but where his words are plain and definite he has the right to expect that no added meanings will be given them, and that if criticised it shall be done upon the ground of what he has actually said, and no other.

It seems to be especially the fate of those who, actuated by motives of true patriotism and fairness, criticise some one thing done by their countrymen, to be charged with having committed high treason, and having declared that everything done by their countrymen is inferior to similar things done elsewhere. In Professor Reuleaux's address he said a number of things in general terms that were highly complimentary to American engineers and mechanics. Most of this was nothing more than is customary on such occasions; nothing more probably than Professor Reuleaux considered that courtesy demanded of him under the circumstances, expressing as he was his appreciation of what had been shown him and what had been done for his entertainment while here a guest of American engineers. The one specific thing which he did say was that about the general use here and high excellence of American measuring instruments, and in this he said nothing but what there is abundant proof of by thousands of disinterested, or at least unprejudiced witnesses.

About two years ago Professor Sweet wrote for our columns an article, the sole object of which was to call attention to the folly of our blinding ourselves to the mechanical achievements of others, and, because we had done much assuming that we had done all that was worth mentioning. Most of the criticisms brought out by this were evidently based upon the assumption that Professor Sweet had declared foreign mechanics and engineers to be superior to American mechanics and engineers, and that we had done nothing here not previously better done elsewhere; something which he did not say and which his recorded words cannot fairly be interpreted as saying.

One writer took several pages of the *Engineering Magazine* to reply to Professor Sweet's article, and instead of replying to it, simply set up a straw man, for which Professor Sweet was in no way responsible, and proceeded to demolish that; without so much as stating where Professor Sweet's article could be found by such of his readers as might desire to find out what had really been said in it.

Another case in point is found elsewhere in this issue, where it is seemingly assumed that we had said that the Chicago Fair was not going to be successful, or was not going to pay, whereas the quotation plainly shows that we intended to say, and all we did say was, that mere brag would not make it successful; and neither did it.

An Improvement Hoped For.

It is to be hoped now, that the silver repeal bill is out of the way, that we shall have some further improvement in the business situation. Indeed there are already many indications that there is to be a gradual return of business to normal conditions. Scarcely any actual condition likely to be imposed by legislation is so bad as a condition of uncertainty—that condition of affairs in which men refuse to go ahead with commercial and industrial operations because all their most carefully made calculations are liable to be upset by impending legislation. Any given line of legislation affecting business having once been determined upon by the people or their representatives, had better be enacted with the least possible delay, so that business may adjust itself to known conditions and go ahead. It is, however, probably true that no way of avoiding a somewhat unsettled condition of affairs while awaiting new legislation can be avoided, so long as such legislation is the result of a gradual growth of public sentiment, the result largely of free discussion, which, in itself, tends to unsettle things. We seem thus to be between two evils: if we discuss and propose changes we unsettle values and suspend business operations; while if we run along in the same channels with no discussion, and without thought of possible improvement we are in a rut, and evils grow up that are all the harder to cure when the time arrives that imperatively demands a cure. One thing seems reasonably certain, and that is, that in proportion as we can eliminate the credit element in business operations, our ability to stand the storms of adversity without serious harm will be increased. It is not the smallest concerns that are now having the hardest times, but those who are in debt, or who by the system of credits are entangled with others as debtors and creditors.

Literary Notes.

COMPOUND LOCOMOTIVES. By Arthur Tarratt Woods, M. M. E (Cornell University.) Late assistant engineer United States Navy. Professor of Mechanical Engineering, University of Illinois, and Professor of Dynamic Engineering, Washington University, etc. Second Edition, revised and enlarged by David Leonard Barnes, A. M., C. E., Member of the American Society of Civil Engineers; Member of the American Society of Mechanical Engineers, etc.

This second edition of "Compound Locomotives," revised and enlarged by D. L. Barnes, will undoubtedly increase the popularity of the original excellent work by the late A. T. Woods. In this book descriptions are given of the various types of compound locomotives which have been in actual service up to date, including all the important developments since the first edition was published. It contains more valuable information relating to the construction and practical value of compound locomotives that have been built and put into service than any other work treating on this subject. Extended theoretical discussions have been avoided because of the small practical value of such analysis with the limited data from actual service available at this time.

The first ten chapters have been prepared with special reference to students, and treat on the elementary indicator cards, clearance, compression, and construction of the expansion curve, mean effective pressure, differences between elementary and actual indicator cards, effect of changing the point of cut-off, pressure in the receiver, combined indicator cards and weight of steam used per stroke, total expansion, ratio of cylinders, receiver capacity, reheating, sequence of cranks, maximum starting power of locomotives, and condensation in cylinders. Chapters 11 to 20 inclusive refer more particularly to the different types of compound locomotives, and are arranged for designers. They treat on the valve gear adjustments, main valves, steam passages, action of the exhaust, effect of heavy reciprocating parts, and descriptions of various types of compound locomotives. Chapters 21 to 23 inclusive are intended to place before the reader an unprejudiced comparison of the different types, and to indicate why double expansion is expected to be more economical than single expansion for locomotives. The book is published by the *Railway Age and Northwestern Railroader*, Chicago, Ill. Price, $3.

QUESTIONS AND ANSWERS.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet.

(544) H. G. S., Fitchburg, Mass., asks: What should be the width of the space for a steam jacket around a cylinder 20 inches in diameter? *A.*—About ¾ inch.

(545) J. K. M., Boston, Mass., writes: Please explain the symbols given to indicate the size of screws, such as 4—32, 6—32, 4—40, etc. *A.*—The first number in each set indicates the gauge number, and the second number indicates the number of threads per inch.

(546) A. M. S., Bridgeton, N. J., writes: Please inform me of a good way to preserve separately the more important articles which have appeared from time to time in your journal. I have some of the yearly issues bound, but they are cumbersome, and the articles when wanted are difficult to find. *A.*—In our issues of Feb. 13 and March 13, '90 are articles describing plans for doing this.

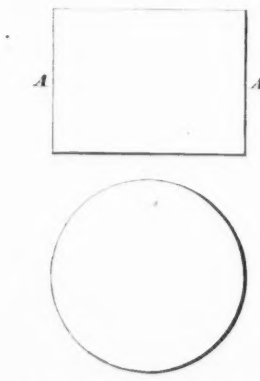
(547) G. B. P., Prenton, Mich., writes: Please inform me where I can obtain a copy of a paper by W. H. Bryan, of St. Louis, treating on the Mississippi river stern-wheel steamboats; or where I can get drawings or sketches showing details of the engines and their valve gear for these steamboats. *A.*—Write to Wm. H. Bryan, mechanical and electrical engineer, Turner Building, 304 North Eighth street, St. Louis, Mo.

(548) G. A. F., Syracuse, N. Y., writes: Please inform me how I can demagnetize a fine caliper, which has been charged to such an extent, by using it around a dynamo, that it is useless to me now; I wish to save it. *A.*—The caliper can be demagnetized to a considerable extent by attaching it to a string, and causing it to revolve very rapidly, and in the meantime gradually bringing it to, and withdrawing it from the poles of a powerful dynamo. But probably the best way will be to take it to a person that demagnetizes watches. Steel may also be demagnetized by heating it to a redness, but this course will not be desirable in your case.

(549) W. D. G., Youngstown, Ohio, asks: Is there a book treating on moments of inertia, modulus of elasticity and radius of gyration? I want a book that explains what these terms mean and how they are computed. *A.*—You will find the information you seek in "Mechanics of Materials," by I. P. Church, published by John Wiley & Sons, 53 East Tenth street, New York. Q. I noticed in your issue of October 5th you give in answer to Question 493 the thickness of a hydraulic cylinder, which I cannot compute by a formula you gave some time ago. *A.*—You will find the formula given and the example worked out in answer to Question 543 in our issue of November 2d.

(550) S. B., Brooklyn, N. Y., writes: Please state whether the following dimensions of an engine I am building are about correct: Cylinder, 2½x3½ inches; steam ports, $\frac{3}{16}$x1½ inches; steam pipe, ½ inch diameter; exhaust pipe, ¾ inch diameter; two fly-wheels, 9 inches diameter, 2 inches face; rim, ¾ inch thick; each weighs about 15 pounds. Shaft, 1 inch diameter; crank-pin, ¾x¾ inch; wrist-pin, ¾x¾ inch; main bearings, $\frac{15}{16}$x2¾ inches; length of connecting rod, 12 inches. The engine is a center crank engine. *A.*—We should prefer the diameter of the crank-shaft to be not less than 1½ inches. For a center crank, the diameter of the crank-pin should be equal to that of the shaft. The fly-wheels should be about 12 inches in diameter, and each should weigh about 35 pounds. Otherwise your dimensions are correct. 2. How fast should the engine be run? *A.*—About 400 revolutions per minute. 3. What is the latest cut off the engine should have? *A.*—A cut-off at ⅞ to ¼ of the stroke will answer your purpose. 4. How much lead should the engine have? *A*—About $\frac{1}{64}$ inch.

(551) W. L., Dayton, Ohio, writes: During the sessions of a mechanical drawing class I have had a dispute with the instructor in regard to shade lines on cylindrical and spherical surfaces. I contend that both lines *A* and *A'* in the accompanying sketch should be light lines, and that a circle representing a sphere should be a light line around its entire circumference. The instructor says that the line *A'* should



be a shade line. Please state who is right? *A.*—Although it is a common practice to make the line *A'* a shade line, it cannot be said that this is correct. Shade lines should always represent those edges and elements of a body which cast shadows, and since the element of the cylinder represented by the line *A'* in the sketch does not cast a shadow with the rays of light falling upon it, as they are assumed to do in mechanical drawing, the line *A'* should not be a shade line. The circle representing a sphere should be a light line. 2. Should a cylinder be shaded darkest along the line *A'*, or should the darkest shade be a slight distance from *A*? *A.*—The darkest shade should be kept a slight distance from *A'*.

(552) J. C. A., Oakland, Cal., writes: I have heard it stated by machinists, but who gave no reason for the statement, that with a given power, more work will be performed, such as raising water, with a 6-inch eccentric, than with a 6-inch crank. Is this statement correct? *A.*—No. We, of course, presume that by the term, "6 inch eccentric," you mean an eccentric whose throw is equal to twice 6 inches. The action of an eccentric is precisely the same as that of a crank; in fact an eccentrice is nothing more or less than a crank with a crank-pin whose diameter is larger than the length of the crank, and therefore no more useful work can be obtained by the use of an eccentric, than by an ordinary crank; in fact, the useful work will be less by the use of the former, as more work is consumed in overcoming the resistance of friction of the eccentric. An eccentric is seldom used in any case where general design and space will permit the use of a crank. 2. I want to build a small model of a gas engine of about ¼ horse-power. Can it be built? Engineers have told me that in so small an engine the gases cannot be compressed sufficiently for combustion. *A.*—An engine of the above size can be built.

(553) H. G., ——, writes: Please inform me through your columns the cost of furnishing a class of 15 students in mechanical drawing with tools, etc. I am about to seek pupils in the evenings, and would like to know the size of tables, and whatever I may need for a class of beginners. If you have given this information in the past, please state in what issue I may find it. *A.*—The size of drawing board we would recommend for beginners is 28 inches long and 21 inches wide. There are different ways of making a drawing board as described in our issue of November 20, 1886, in this article we also point out the best kind of board to use. In the same issue the size of T-square is given. Each student will need the following tools: One set-square with angles of 30, 60 and 90 degrees, its longest side should be about 13 inches long; one set-square with angles of 45 and 90 degrees; its sides, which are perpendicular to each other, should be about 8 inches long. One 4-inch compass with needle point, movable leg, pen and pencil, and a plain pair of dividers, as illustrated in our issue of December 4, 1886; one drawing pen, illustrated in our issue of November 27, 1886; a triangular scale 1 foot long; a spring-bow pen, pencil and dividers, a protractor, and curves, as illustrated in our issue of February 19, 1887; a H H H H pencil, thumb tacks and rubber. The paper you can buy in rolls. We do not deal in drawing materials, and therefore cannot quote the lowest prices, but these you can get from any first-class dealer in drawing materials. See our advertising columns.

(554) J. M., ——, Michigan, writes: We have a boiler to set up which is to be used for steam heating purposes in connection with the low-pressure gravity system. The boiler is 12 feet long over all and 40 inches in diameter. The fire-box is 52 inches long. The type of the boiler is what we call a common fire-box boiler. We shall build a brick wall all around it. Now what we wish to know is whether there is any advantage in returning the heated gases to the under-side of boiler up to the fire-box and then allow them to escape? We have examined several plants and find a clear space left under the boiler so that the gases can return to the side of fire-box, where they are allowed to escape through an iron pipe. We do not like this way of setting as the soot collects in this space and is liable to be set on fire two or three times a season. The fire department here has been called out two or three times to a plant of this kind, which has been in operation one season only. If you think the boiler would be as economical in fuel without returning the gases to the under-side of boiler we would rather have it so. Of course we know the soot could be cleaned out, but all these plants are run without an engineer and have to take care of themselves; it does not seem as though it was anybody's business to look after anything but the fire. If you could let us know the proper way of setting up such a boiler we shall be pleased to hear from you. We should mention that wood will be used for fuel. *A.*—The return of the hot gases to the under-side of the boiler will tend to produce economy in fuel. The collection of soot in this space should not be an objection, as there will be no difficulty in providing suitable openings in the walls for cleaning and examination of the boiler. If there is no return flue, the soot will collect in other places, which may be far more injurious than the collection of soot in the return flue. It seems to us that an owner of any kind of boiler for the sake of his own interest should insist on a proper care of the boiler; neglecting this, and allowing the boiler to take care of itself, may, in many cases, amount to criminal negligence. We prefer the return flue boiler provided with all the facilities required for cleaning and examination.

(555) A. J., Pittsburgh, Pa., writes: Kindly inform me how large the diameter should be of a cast iron beam supported at one end and loaded with 15 tons at a distance of 12 feet from the support? Please give rule for finding this diameter? The form of the beam is to be a frustum of a cone. *A.*—The large diameter at the support is computed from the following formula:

$$d^3 = \frac{10.185 \times l \times W}{3}, \qquad (1)$$

in which d denotes the diameter at the support in inches; l the length of the beam in inches; and W the load in tons. Substituting for the symbols their values, we have

$$d^3 = \frac{10.185 \times 144 \times 15}{3} = 7{,}333;$$

the cube root of this result is 19 43, say 19½ inches for the diameter at the end of support. The diameter at the small end of the beam should be ⅔ of the large diameter, or 19½ × ⅔ = 13 inches. This does not include the weight of the beam. To include this divide the distance from the support to the center of gravity of the beam by the length of the beam; this will give a fraction; multiply this fraction by the weight of the beam of the dimensions as found above, and add about 2 per cent.; add this whole sum to the load W, and then find new dimensions for this beam by formula 1. This formula has been obtained from the fundamental formula $M = \frac{S\,I}{c}$, in which M denotes the bending moment; S the unit stress on the fiber most remote from the neutral axis; c the distance to this fiber from the neutral axis, and I the moment of inertia. For a circle of the diameter d, $I = \frac{3.1416\,d^4}{64}$, and $c = \frac{1}{2}\,d$, hence

$$M = \frac{S \times 3.1416\,d^4}{\frac{1}{2}\,d \times 64}, \text{ which}$$

$$\text{reduces to } \frac{S \times 3.1416 \times d^3}{32}.$$

For a beam supported at one end and loaded at the other, $M = W \times l$. Hence we have

$$W \times l = \frac{S \times 3.1416 \times d^3}{32}.$$

By taking a value of 6,000 pounds, or three tons per square inch for S, formula (1) is easily obtained from the last equation.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Grant's Gears, Lex'n, Mass., & Phila., Pa. See p. 12

Forming Lathes Mer. Mach. Tool Co., Meriden, Ct.

6-Spindle Turret Drills. A. O Quint, Hartford, Ct.

Milling Machs. Kempsmith M. T. Co., Mill., Wis.

Pattern and Brand Letters. A variety of sizes and styles. Heber Wells, 8 Spruce St., New York.

Davis Key Seating Machines kept in stock by Manning, Maxwell & Moore, 111 Liberty St., N. Y.

Selden Packing for stuffing box, with or without rubber core. Randolph Brandt, 38 Cortlandt St., N.Y.

Pulley lathes, most efficient offered. The Lodge & Shipley Machine Tool Co., Cincinnati, O.

Air Compressors for every possible duty. Clayton Air Compressor Works, 43 Dey Street, N. Y.

Steam Pressure Regulators, Reducing Valves, Safety Checks. Foster Engineer'g Co., Newark, N. J.

Guild & Garrison, Brooklyn, N. Y., manufacture steam pumps, vacuum pumps, vacuum apparatus, air pumps, acid blowers, filter press pumps, etc.

Split Pulleys at low prices, and of same strength and appearance as Whole Pulleys Yocum & Son's Shafting Works, Drinker St., Philadelphia, Pa.

For best Return Steam Traps, Pressure Regulators, Positive-Acting Pump Govs, Back-Pressure Valves. T. Kieley, 11 W. 13th St., N.Y. Send for des'n.

Improved Duplex and Special Gear Cutters in stock and to order; Gear and Milling Cutters of all descriptions. R. M. Clough, Tolland, Conn.

"Pumping Machinery." New book, 450 pp, 8vo, 270 Eng. Prospectus free. W. M. Barr, 3223 Powelton Avenue, Philadelphia, Pa.

"Binders" for the AMERICAN MACHINIST. Two styles, the "Common Sense," as heretofore sold by us and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers with full page opening flat. Either will hold the entire 52 issues of any volume. AMERICAN MACHINIST PUBLISHING CO., 203 Broadway, New York.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator and making all required calculations from the diagram, also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price, $2 postpaid. Published by John Wiley & Sons, 53 East Tenth Street, New York.

A refreshingly egotistical and bombastic English engineer writes to *The Practical Engineer* an account of his journey from Chicago to Detroit, which seems to have been "a chapter of accidents," and he incidentally mentions that he gained admittance to the Ferris Wheel at Chicago by presenting "my card (specially printed with gold edges, etc., for American use)." If he did this he, of course, made an exhibition of himself, and was quietly laughed at wherever his "specially printed" gold-edged cards were presented. But one of the most amusing features of our British critics is their delightful unconsciousness of the exhibition of bad taste, which they themselves make, while expressing their disgust with what they see here. It is morally certain that this Englishman's own cards were the only ones he saw while here that had gold edges, but that circumstance taught him nothing, and did not even deter him from rushing into print to reveal his own unsophistication.

Monthly Meetings of Engineers.

In accordance with an invitation issued by M. N. Forney, some fifteen members of the American Society of Mechanical Engineers met at the society's house, 12 West Thirty-first street, New York, Wednesday evening, November 2d, and effected a preliminary organization for the purpose of holding meetings for the informal discussion of professional subjects.

On motion of J. F. Holloway, Mr. Forney was made chairman, and Gus. C. Henning, secretary.

After reading letters written by various members in response to the proposition to hold such meetings, a resolution proposed by Wm. F. Durfee, and amended by Prof. F. R. Hutton, was adopted as follows:

Resolution.—It is moved that it is the sense of this meeting, that it would be desirable and profitable that an opportunity be given for members of the American Society of Mechanical Engineers to meet at convenient times during the coming winter for the discussion of subjects pertaining to mechanical engineering.

It is further moved that a committee of five be appointed to arrange for such a series of monthly meetings during the coming winter and following spring, that it be authorized to select and appoint a chairman to preside, to fix the dates for holding, and issue calls for such meetings, select subjects for consideration, and speakers to present and discuss them, arrange the order of proceedings and make all necessary rules for the conduct of such meetings, solicit subscriptions to defray the necessary expenses, audit and pay all bills for such expenses and fill all vacancies which may occur during the period named.

There were present, Commodore Charles H. Loring, J. F. Holloway, C. W. Hunt, William H. Odell, George L. Fowler, William Kent, James McBride, W. S. Doran, C. H. Platt, F. H. Stillman, William F. Durfee, A. E. Mitchell, Gus. C. Henning, Prof. F. R. Hutton.

As soon as the committe is formed and a subject chosen for the first meeting notices will be sent out. It is understood that any engineer, whether a member of the A. S. M. E. or not, will be welcome at these meetings.

Development of the Watch Industry.*

BY AMBROSE WEBSTER.

Before taking up the subject of the American watch industry, let us consider for a moment the condition of the foreign industry up to 1850, that being the date at which Mr. Dennison may be said to have given this industry a start on the road to prosperity.

The first pocket timekeepers were made in Germany. The oldest I have seen was in the British Museum in London, being an alarm watch. The date of its construction is said to be previous to 1520. This watch is a very crude affair as were all made before 1750 One writer has observed "that if they were wound twice a day and the hand set every hour they would keep pretty fair time." I use the word "hand" in the singular, because these watches, like many of the tower clocks now in the country towns and villages of Switzerland and France, have only one hand, viz., the hour hand.

I have brought for your examination two of the earlier English-made watches; the larger one was made in 1690 by W. Wind-

*Paper read before the Citizens' Club of Waltham, Mass.

mill, of London. This watch was made for a pasha in Northern Africa, and has upon its case emblems significant of his possessions, there being three devices, indicating three different sections of the country over which he was ruler. It was formerly studded with jewels. This watch was bought during political troubles in Cuba, from a refugee who removed the jewels as he needed funds. One night he came into the store of an American watchmaker and offered to sell him the watch, and after some hasty dickering, it was bought at a very low price. He said, "I must leave the island this night. I am liable to arrest." I purchased it a few years ago as a curiosity. The smaller watch, also of English make, was made by William Addis, date of manufacture unknown, but probably about 1700.

The American Waltham Watch Company has a watch made in 1620, before hair springs were invented, or chains made. The watch is driven by a main spring in a barrel, using for a fusee chain a cat gut.

Watchmaking in its earlier stages was developed from a very small beginning. Some ingenious man with a very small amount of tools, managed to get together a watch, which he sprung, adjusted and regulated so nicely that it gave him a reputation. He was asked to repeat it, and he called in the assistance of other watchmakers to help in this work. Other orders following, he became a watch manufacturer, but his shop was made up of watchmakers.

The first steps of the American industry were very similar, but time will not allow allusion to all attempts that have been made, the most notable one being that of Mr. Goddard, of Shrewsbury, Worcester County, who in 1790 made a few watches. In this work he was assisted by some British soldiers, watchmakers, who were sent over during the war of the revolution, and with their assistance he is said to have made about 600 watches. One of these watches, No. 277, lies upon the table.

Mr. William H. Keith, the second president of the American Watch Company, was one of his apprentices, and he informed me that the hands, dials, main springs, hair springs, escapements, chains and pinions were all imported, consequently Mr. Goddard did not take high rank as an American manufacturer.

The first attempt to *manufacture* watches in this country was made by Pitkin Bros., who in 1835 commenced the manufacture in a small building in East Hartford, Conn. They afterwards removed to New York, and finally were obliged to close up business, the panic of 1837 being the principal cause of this result. It is said that they made about 400 watches. I am the fortunate possessor of No. 60 of the Pitkin watch, which also lies upon the table for examination. Mr. N. P. Stratton, formerly foreman at the American Watch Company, and afterwards superintendent of the Nashua Watch Company, was one of Pitkin Bros.' apprentices.

The next attempt to manufacture was made by Mr. A. L. Dennison, to whom is conceded the proud title of "father of the watch industry of America." Mr. Dennison was born in Maine, learning the watch repairer's trade in Brunswick, afterwards working in New York and Boston as a repairer. He early conceived the idea of manufacturing watches upon what is termed the American principle of interchangeable parts. And as early as 1845 he commenced the study of this problem. Being an enthusiast, and having a persistent and determined character, he devoted all his spare time to the consideration of details of the manufacture, making notes of his conclusions, and his prolific brain seemed to have wrought out all the details of systematic factory management. He had pronounced ideas upon the marketing of the goods and the demands of the American market, and so thoroughly had he covered these subjects that several years after he had severed his connection with the American Watch Company, in discussing some projects for the future development of the business, I remarked to Mr. Robbins that Mr. Dennison had once proposed a similar plan to the one under consideration, and he replied that "there was scarcely anything that could be thought of in the line of watch manufacture that Mr. Dennison had not at some time proposed."

In 1847 or 1848 Mr. Dennison met Mr. Howard, of the firm of Howard & Davis, manufacturers of hand and fire engines, post-office scales, church clocks, etc., and interested him in the subject of watch manufacture, succeeding in diverting his mind from engaging in the manufacture of locomotives and to engage in that of making watches, and they commenced business in a room adjoining the clock factory in Roxbury, Mass. They soon afterward erected the building on Hampden street, which now bears the sign "The First Watch Factory in America," which, however, is an error, as Pitkin's factory, of East Hartford, was the first.

Among the early employes were two brothers, O. B. and D. S. Marsh (the latter now a resident of Waltham), James Baker, James T. Shepard and B. A. Buckley, who are still in the employ of the American Watch Company. The first machinist regularly employed in the watch industry was Charles S. Mosely, a very ingenious mechanic, and to his inventive genius, coupled with that of Mr. Dennison and Mr. Howard, the watch industry is indebted for many devices which laid the foundation for the success of the business.

I cannot attempt in this essay to give due and just credit to all who have been interested in the mechanical development of the business, but I think no one will disagree with me in saying that these three names, being the earliest, are entitled to stand at the head.

They first attempted to make an eight-day watch. Mr. D. S. Marsh, who made the model, has still one of the first in his possession, and has kindly loaned it for your examination.

After many mechanical and financial failures the business increased to a size when it was deemed necessary to make a change from Roxbury to some place free from the dust and attractions of the city, and Mr. Dennison, seeking for such a place, through his affiliation with the members of the New Church at Piety Corner, came to Waltham, and hearing of Stony Brook, and attracted by the romantic surroundings below the so-called Sibley machine shop, which strongly reminded him of the Swiss factories, he opened negotiations for the purchase of a site. Not being successful he started on his return to Boston, and made a neighborly call on his old friend, S. P. Emerson, then in charge of the machine shop of the Boston Manufacturing Company. He stated his errand and his disappointment at not securing a site, and Mr. Emerson suggested that the Bemis farm across the river had been sold, and it might prove a good location. He escorted Mr. Dennison across the dam, and they finally fixed upon the present location of the American Watch Company as a proper site, and negotiations were commenced which finally resulted in the formation of the Waltham Improvement Company, and the erection of the first watch factory here, which is shown by the picture that hangs there upon the wall. The building was termed the "mud factory," it having been made of concrete masonry filled in between planks set in proper position, and building up the walls in successive stages.

Owing to insufficient capital, the business was not developed mechanically, and consequently was not financially successful, and in April, 1857, it was sold at auction, Mr. Robbins, treasurer of the present company, furnishing the capital, bidding it off in the joint interest of himself, and Messrs. Tracy and Baker of Philadelphia. The price paid was $56,500, but this did not purchase the entire plant. Some of the tools and material, it is claimed, belonged to other parties, and was removed to Roxbury, forming the nucleus of the present E. Howard Watch Company.

The first appearance of Mr. Robbins upon the stage brings to mind an interesting fact, viz., that on Mr. Dennison's first visit to England, for the purpose of opening up avenues for the purchase of material, and studying the system of gilding and other operations of the English watch manufacturers, he says that as the vessel drew up to the wharf in Liverpool, he saw Mr. Robbins awaiting the landing of the passengers. Being acquainted with Mr. Robbins, and not desiring to have the object of his visit known, he avoided him, waiting upon the vessel until Mr. Robbins had departed. He little thought at that time what the future was to bring forth for both himself and Mr. Robbins.

After the auction sale the business was started under the name of Tracy, Baker & Co., but a difficulty arose between the members of the firm that soon terminated the engagement. The difficulty was in dividing between Messrs. Tracy, Baker and Robbins, the proportion of their interest in the plant.

The Waltham Improvement Company was organized in 1854, with a capital of $100,000 divided into shares of $1,000 each. Stock was rapidly taken by 60 persons, the Boston Watch Company taking $30,000 worth of stock. When the act of incorporation was being considered by the house, a wag wrote upon a copy of it:

"A Waltham patent lever watch, which, 'ere it goes,
Besides the hands, must have the 'ayes and noes.'"

In October of 1857 the financial panic was so severe that the company was obliged to resort to a reduction of time and wages, the business struggled along through a few succeeding years, in fact, up to 1861 it could not be said to be successful. In 1858 they joined with the Waltham Improvement Company, forming the American Watch Company.

The late unpleasantness, as we term the war of the rebellion, proved of great advantage to the watch industry, in fact I firmly believe that it was the principal cause of the rapid development which we have known since that time. This development is well known to most of our citizens. The great financial success and the great mechanical successes have been due to the intelligence and business management of Mr. Robbins, and the mechanical genius of the employes, and I only wish time would allow me to allude to them in detail.

The success of the Waltham factory has stimulated imitators and copyists. Most of the projects have been started by men who believed they were competent to start and run a watch factory, or by men who thought they had a watch of superior design, and oftentimes started in the west by a desire "to boom our town."

I can but barely allude to some of the attempts to start watch factories by parties seceding from the American Watch Company, or by men who were either directly or indirectly connected with the Waltham factory.

The first was the return of E. Howard to Roxbury. This company is still in existence, and making about twenty-five watches per day. They have never attempted to make anything but the high grade of watches, and have probably invested in this work a capital of $200,000.

The Nashua Watch Company started in the fall of 1859. The prime movers in this company were N. P. Stratton, Charles S. Mosely and D. B. Bingham. This factory drew from Waltham several men who afterwards became quite prominent, viz., Charles V. Woerd, James B. Gooding and James H. Gerry. This company spent about $53,000, when they were bought out by the American Watch Company and moved to Waltham.

In the fall of 1860, Mr. Dennison left the American Watch Company and soon organized the Tremont Watch Company, interesting Mr. Bigelow, of the firm of Bigelow & Kennard Brothers. This company was organized with a capital of $200,000. They first started in a shop in Boston, and soon removed to Melrose, Mass. Mr. Dennison went to Switzerland and organized a department there for the manufacture of wheels and pinions, while the plates, etc., were made and the setting up done in Melrose. This factory was closed in 1868 and the machinery was taken to England and formed the nucleus of the English Watch Company, of Birmingham, but it never proved a success.

In 1863 there was an attempt made in Newark to manufacture watches, in which the firm of Fellows & Schell, of New York City, were the financial backers. This company spent about $200,000, when it moved to Chicago, taking the name of the Connell Watch Company. It was finally moved to San Francisco, where an attempt was made to organize a company, but the sudden death of Mr. Ralston put an end to the project, and the machinery was returned East and finally disappeared.

In 1863, the firm of Giles, Wales & Company, of New York, organized the United States Watch Company, of New Jersey, which was located at Marion, a suburb of Jersey City. The superintendent of this factory was James H. Gerry, who took with him some of the Waltham operatives, among whom was H. J. Cain, subsequently superintendent of the Hampden Watch Company. Mr. William B. Learned, who succeeded Mr. Gerry as superintendent, was from Waltham. In 1872 this concern finally suspended operations, and its machinery was sold to different parties.

In 1864, the project of starting a watch factory in the West was broached by J. C. Adams and N. P. Stratton, the latter then connected with the Waltham factory. It finally culminated in the organization of a factory which is now located at Elgin, Ill. This company also took its leading men from Waltham, viz., Charles S. Mosely, George Hunter, P. S. Bartlett, J. K. Bigelow, Otis Hoyt and several others. Charles S. Mosely was superintendent until 1876, when he resigned, and George Hunter, the present efficient superintendent, succeeded him. Since he assumed the management, this factory has made rapid growth, and is now turning out as many watch movements as our own Waltham factory. A large view of this factory is before you.

In 1864, a watch factory was projected in Providence, which was finally moved to Springfield, and after several failures became the Hampden Watch Company, which has recently been moved from Springfield to Canton, O. The capital of this company is $400,000, and they are able to produce 300 watches per day.

Mr. Mozart, who started the factory in Providence, made another attempt at Ann Arbor, Mich., which proved a failure.

The Freeport Watch Company was formed in Freeport, Ill. After the factory was completed and the machinery partially set up, it was destroyed by fire, and no attempt was ever made to rebuild.

The Springfield, Ill., watch factory was started in 1869, organized by J. C. Adams, and his leading mechanics were J. K. Bigelow, superintendent, Otis Hoyt, C. E. Mason, John Nickerson and Daniel Currier, all graduates of the Waltham and subsequently of the Elgin factory. This factory has gone on with variable success, and is running at the present time, producing about 400 watches per day.

In 1871 a factory was started at Rock Island, Ill. This proved a failure.

J. C. Adams again appears in 1874, organizing a watch factory in Lancaster, Pa. This institution has never been successful, and is now about to be sold at auction, the machinery having been idle for the past two years.

In 1874 a watch factory was organized in Rockford, Ill., and is still running, producing a very fair grade of watch, in a limited quantity, probably about fifty per day.

In 1875 an attempt was made to organize a watch factory in Fitchburg, Mass., and some machinery was built, but no watches were ever produced. In 1876 a small private enterprise for making watches was started in Columbus, O., which has finally developed into the Columbus Watch Company, which has been successful financially, and is still running, producing a good quality of work.

The watch factory next in order was organized in 1877 for the purpose of building

a toy watch. Of all the various watch factories that have been started either in this country or abroad, I believe it is true that only one has been started upon sound business principles, viz., the Waterbury Watch Company. This company had a definite article to manufacture, and it was to make but that one. There was money enough to equip a plant in the best possible manner, and the courage to put it in as required. The best talent that could be secured was employed both in planning the arrangement of the factory, its architectural features, and in the designing of its machinery and organization of the system of manufacture, and I take pleasure in saying that one of our Waltham architects has added to his reputation by designing what is conceded by all to be the finest watch factory building in the world. I allude to our friend, Mr. H. W. Hartwell. A view of this factory is hanging upon the wall.

In 1880 the Fredonia Watch Company, of Fredonia, N. Y., was organized, which has since moved to Peoria, Ill. This factory is now running and producing a small quantity of watches.

In 1883 a watch factory was started in Cheshire, Conn., the intention being to make a very cheap watch, but it was not successful financially, and the factory is now closed.

In 1883 the New Haven Watch Company was organized in New Haven, Conn., which has since moved to Trenton, N. J., and is now known as the Trenton Watch Company. The factory was closed for a while, but is again running, with a new model, and the managers express a hope of building up a large business.

In 1883 the Manhattan Watch Company was organized to make low-priced watches only. It has been running very fitfully, as trade has been irregular, and I know very little of its history. No prominent Waltham men have been connected with it.

In 1883 the Seth Thomas Clock Company decided to manufacture watches, and purchased tools and machinery for that purpose, and engaged some very skillful men, and are now making a moderate quantity of medium-priced watches.

The Aurora Watch Company, of Aurora, Ill., was organized in 1883, and is now making about 75 watches per day.

In 1884 the United States Watch Company was organized in Waltham. Its history is too well-known to you for me to do any more than enumerate it among the list.

The New York Standard Watch Company was organized in 1885, to manufacture what is called the screw escapement, which was soon changed to the regular lever escapement. The company is now making about 200 watches per day.

In 1887 one of the most ridiculous attempts at watch-making was made at Wichita, Kan., where a fine stone building was erected on the prairie several miles from the city. No machinery was ever put into it, and it stands as a monument to the folly of its projectors. Twenty-five thousand dollars were spent on the building.

There have been in the United States 36 attempts at watch manufacturing. Nineteen have died, although some have been resurrected, and there are now 17 factories capable of turning out 7,500 watch movements per day, employing a capital of $10,000,000. These factories employ 12,000 operatives, of whom 5,000 are females, who receive an average pay of $1.50 per day, while the 7,000 men receive an average of $3 per day, the daily pay-roll being $28,500. These 12,000 operatives are supporting at least 40,000 people.

It is almost impossible to get very definite facts relative to the condition of the business of watch case making in 1850, but it seems to have been started in Philadelphia. Mr. T. B. Hagstoz, formerly of the Keystone Watch-Case Company, who succeeded the firm of Tracy, Baker & Co., as case manufacturer, had intimate relations with Mr. Tracy, and from him I learn that in 1850 there were eighteen shops for repairing and manufacturing watch cases, turning out about 285 cases per day, and employing a capital of $285,000. In 1890 there were 47 watch-case manufacturers, able to turn out 6,000 cases per day, and employing a capital of nearly $5,000,000, and a reasonable estimate is that they employ 5,000 operatives, who receive an average of $1 60 per day, making a total pay roll of $8,000, and it is also reasonable to suppose that the case business supports 25,000 persons.

I think it is safe to say that the watch industry of America in all its various departments of manufacture, distribution of goods, etc., is supporting at least 100,000 people. Compare this with the condition of things in 1850, when only five movements were made per day, requiring only five cases per day. More cases were made for foreign markets, which were imported in large quantities.

We of Waltham can truthfully claim that the American Waltham Watch Company was the first and only watch factory in the world to manufacture an entire watch from what may be termed the raw material, wire, brass and steel and brass poundings being the only articles bought in any stage of forwardness.

Of the graduates of the American Watch Company, who have been prominent in the watch business, it is proper to name Charles S. Mosely, N. P. Stratton and D B. Bingham, who started the Nashua watch factory; George Hunter, J. K Bigelow, P. S. Bartlett, Otis Hoyt and Charles Mason, who started the Elgin watch factory, of which George Hunter is now superintendent; J. K. Bigelow, P. S. Bartlett, Otis Hoyt, Charles Mason and Currier, who started the factory at Springfield, Ill; H. J. Cain, formerly superintendent of the Hampden, now superintendent of the Aurora; W. W. Hastings, superintendent of the New York Standard Watch Company; R. Moreland, superintendent of the Trenton; William B. Learned, superintendent of the E. Howard, and William Owens, superintendent of the Columbus Watch Company. Among the fine mechanics and workmen who are not now connected with the watch factories are many names that might be mentioned. I firmly believe that the development of the watch industry in this country has done more to elevate the quality of mechanical work, and produce extremely fine workmen and mechanics, than any other industry that has been started within the century.

My first acquaintance with the Waltham factory was in May, 1857. Arriving at the Waltham station, I crossed the Moody street bridge and walked up to the watch factory. It may be interesting to note what I then observed. The first object on my right was the celebrated stand of Colonel Mason, a gentleman of portly size and loud voice, all of which was needed to frighten the boys who clustered around the place. Colonel Mason is entitled to the credit of inaugurating the boating feature of Charles River. He was the proud possessor of two boats, the only two on the river, one of which he named "Signet." By this name he put the *seal* of his approval on that beautiful bird, the swan, but sadly missed the correct spelling of its Latin name, "cygnet." Colonel Mason was quite a mechanic in his line, having a very high opinion of himself, and in comparing himself with the skilled workmen of the factory, he said, "They think they are mighty smart at the factory; they have some good workmen, but I don't believe any of them can make a brand," that being the special work on which he prided himself. Colonel Mason also had the honor of introducing the first public bath house in Waltham. It consisted of a half a hogshead with a pump at its side, over and around which he had erected a rough building, and bathers were at liberty to step into the tub, and pump the water on themselves. The building was adorned by a sign saying, "6 cents a wash."

The second building was the celebrated Knowlton's corner, being a beer shop, and it was said that many a dime of the watch factory employes was dropped into this place on their way to and from the factory. The third and fourth buildings are on the south side of Crescent street, being the dwelling houses of Mrs. Kendall and Samuel D. Whitney; the fifth was a dwelling house of Otis R. Blood; the sixth a dwelling house of Mr. Colby. Opposite was the house of Cushing Kendall. Further up the street on the right side was the "grandee"; next came the house of John Locke; and next the house of a Mr. Owen; next the house of a Mr. Stratton, engaged in the then so-called bedstead factory, now occupied by J. L. Keyser; next the house of John Moore, and the last the house of James Baker, now removed, the site being occupied by the treasurer's office of the American Watch Company. Then came the mud buildings of the watch factory, of which the picture is before you. Beyond the factory was the house of George Bergen, now inclosed in the grounds of the company. On the river banks south of the watch factory was another house built of concrete, the same as the watch factory, which was used as a dwelling house. Between Crescent and Adams streets there was standing the "old farm house," so called, being the Bemis farm house, also a house owned by Mr. Wall. and another mud house and a part of the present Shawmut house.

These were all the buildings on Crescent and Adams streets. Crescent street ended at the factory. Beyond it were the woods. Spruce, Walnut and Cherry streets were laid out, and built upon between Moody and Adams streets, but the sum total of the dwelling houses, besides those enumerated, was 17.

The daily output of the factory at that time was five watches per day, being the sum total produced in this country, but when the wind was east the gilding batteries did not work, and the company was unable to turn out any watches. Probably the fumes from the chemistry had something to do with this effect, for at that time it was in full blast for manufacturing vitriol.

What a wonderful growth we have seen in this section of our city! In all my travels I have never seen so many nice dwelling houses, tidy lawns and fences, so many intelligent, well dressed, well behaved people, as are gathered on the south side of the river.

I now desire to call your attention to some of the features of the development in the Swiss industry, particularly to the history of Daniel Jean Richard, who is termed "the father of the Swiss watch industry."

In 1889 I visited Locle, where is erected in front of the horological school, a life-size bronze statue in memory of Daniel Jean Richard. This statue was erected as a public recognition of the fact that he was the first Swiss to attempt the manufacture of watches. The statue represents him as a blacksmith's apprentice, standing by his anvil, examining a watch In 1888 a history of watchmaking in Neuchatel was issued, of which I have a copy present, which gives an illustration of this statue, a picture of his first watch, also a photograph of the painting hanging in the horological school at Neuchatel, representing the circumstances of his first examination of a watch.

Since Daniel Jean Richard's time there has been a great development and improvement in the manufacture of watches in Switzerland, but the nature of the country, the social habits of the people, and their isolation from the rest of the world have prevented that development in the line of the American system which we might naturally have looked for. I found in Beaucourt, in the eastern part of France, a factory that was started in 1777 by Frederick Japy, who was succeeded by his sons, grandsons, and great grandsons, viz., Louis, Pierre, Adolphe, Jules, and Maurice, through six generations. They are employing 1,500 workmen, making 400 watches per day of 12 hours. They are making movements of 25 different sizes, and they assured me that they had produced 4,000 watches which had plain and distinctive differences.

In this establishment I saw large quantities of machinery, automatic notably, for roughing out the barrels, and also an automatic screw machine which in many respects was similar to those used in the Waltham factory, and which bore every evidence of great age. Formerly we were accustomed to say that American watches were the only machine made watches. This statement was never strictly true, many years previous to the commencement of the Waltham project, the Swiss and English were using considerable machinery, but they never appreciated the benefit that would flow from the massing up of the entire manufacture of the watch in one building, under the charge of one man, and the attempt to simplify the manufacture by making only one or two kinds, which should be all alike, and endeavoring to carry out the principle of interchangeability of parts; in fact, they to day do not half appreciate the reasons for the great economy in the American manufacture. By the American system one and one-half persons will make one watch per day, by the English system four persons are required, by the Swiss system five persons.

Recalling to your minds the appreciation of the Swiss for the "father" of their industry, I have a practical suggestion to make, viz., that Waltham at once initiate steps to erect some suitable testimonial to mark the appreciation of Waltham for the services of Mr. A. L. Dennison, and I believe that a popular subscription could be started, to which every person employed in the watch and watch-case factories would be willing to contribute his mite, and I would couple with this suggestion that similar steps be taken to commemorate the establishment of the cotton industry in this city and show the appreciation of our people for the services of Francis A. Lowell in behalf of Waltham and the cotton industry. I know of no better place to locate these than on the southeast and southwest corners of our common, near the railroad station, so that every person arriving at Waltham would be reminded of these two prominent industries of our country, whose influence has spread all over the world.

Genius and Training.

The training of men for work which requires the highest possible nicety of hand is not really training. It is far more the selection, by experiment, of men born with the true touch. For example, we doubt whether the very greatest surgeons—the men whose success depends upon their ability to make sharp steel as sensitive as a finger-tip—perform their hundreth operation better than their first. They have more confidence, no doubt, but the sleight-of-hand is inborn. No body can train a medical student into a great oculist. It is only the ordinary man of whom it can be said that practice makes perfect. The man with the special gift is born perfect. But genius is only the mental side of this gift, apart, and if the people whose business is with mind were as honest and as unsophisticated as those who deal with horse racing or bricklaying, we should not hear anything more about genius being merely the capacity for hard work. To say that the bricklayer with the "knack" is only a bricklayer who takes pains, would be a patent absurdity. It is not less an absurdity, though a less obvious one, to say that a man with a genius for style and literary form is only a man who knows how to take pains. The poet, no doubt, must take pains, but no amount of taking pains will give him the genius of verse.—*London Spectator.*

A Large Water-wheel.

In these days of "big things" the water-wheel makers are not being left behind, and James Leffel & Co., of Springfield, Ohio, have recently shipped to Niagara Falls a turbine wheel which is to develop 1,200 horse power. This wheel is on a horizontal shaft, and is known as the "double discharge" type, its entire weight being 30 tons. The pipe leading to the wheel will be eight feet diameter, and the head will be 180 feet.

MANUFACTURES.

The Wheeler Projectile Works, Demmler, Pa., are now running full.

The preparation for the building of the electric light plant, at Lakeport, Mass., has begun.

The Iowa Farming Tool Co., of Fort Madison, Ia., has increased the capacity of its works.

The works of the Dowden Mfg. Co., Prairie City, Ia., recently destroyed by fire, will be rebuilt at once.

The Monongahela Iron and Steel Co., Hays Station, Pa., has put on eight more puddling furnaces.

The Clonbrock Boiler Works, Brooklyn, N. Y., have sold all their boilers exhibited at Chicago—aggregating 3,000 horse-power.

The Oliver Iron and Steel Company, Pittsburgh, started the puddling department of their South Fifteenth street mill October 23d.

The Case Threshing Machine Co., Racine, Wis., are building a new foundry, which is to be very completely equipped for the purpose.

The new factory of the Phillips Insulated Wire Co., of Pawtucket, R. I., will be 186x50 feet, and will have three stories and a basement.

The Tonawanda (N. Y.) Iron and Steel Co. has started work after an idleness of nearly three months, giving employment to 200 men.

The Ball & Wood Engine Company, of Elizabeth, N. J., whose works have been running only five days a week, have resumed on full time.

The mill of the Westminster Paper Company, Bellows Falls, Vt., which has been running on half time for several weeks, is now on full time again.

Riehle Bros'. Testing Machine Co., Philadelphia, Pa., issue a complete catalogue of machines, tools, etc., made by them, which will be sent on application.

The National Tube Works Company, of McKeesport, has three-fourths of its plant running double turn. In the pipe-mill nearly 2,000 men are employed.

The Lebanon Boiler, Foundry and Machine Co., Lebanon, Pa., are fitting up a large brick building as a machine shop, which they expect to have running shortly.

Blast furnace No. 1 of the Burden Iron Company, Troy, N. Y., which had been idle five months while being rebuilt, was recently blown in. Employment was given to 100 additional men.

The Snell Mfg. Co. has been organized at Berwick, Me., for the purpose of making frame saws; $100,000 capital stock. The officers are: President, William Butler; treasurer, Albert Edgecomb, of Boston, Mass.

Beginning November 1st, the large locomotive works of the New York, Lake Erie & Western Railroad, at Susquehanna, Pa., will be in operation forty-eight hours per week, instead of twenty-four hours as heretofore.

Reports from all over New England show a much better state of affairs than has existed for some time. Mills and factories are resuming, and many thousands, forced by hard times to idleness, are now returning to work.

The Phillips Wheel Company has been incorporated to manufacture bicycles in Rochester, N. Y. Capital $150,000. Directors: Charles Phillips, Henry S. Durand, Edward R. Jennings and William W. Mumford, of Rochester.

The Ohio Fall Iron Works, of New Albany, Ind., is now running to its full capacity. It has been running exclusively on orders for the last three months, and has orders on hand sufficient to keep it going for some time to come.

October 27th, men to the number of 375 were put at work in the Walter A. Wood Mowing and Reaping Machine Company's Works, at Hoosick Falls, to fill an order from South America for 367 harvesters and binders and 247 mowers.

The following departments of the Cambria Iron Company, of Johnstown, Pa., have started up: Nos. 1 and 2 mills, the 27-inch billet-mill and slab-mill, the Bessemer steel works and blooming-mills, and the open hearth steel works.

The Vulcan Steam Boiler Works has been incorporated to manufacture boilers, engines and steam machinery, at Brooklyn, N. Y. Lucien Knapp, of Long Island City, Frank H. Woodruff, of Brooklyn, and Charles Balloch, of New York, are directors.

George W. Fifield, Lowell, Mass., manufacturer of engine lathes, is erecting a new steel covered shop 250x60 feet, with two L's, each 120x60 feet. The new building will be connected with the main line of the Boston & Maine Railroad by a side track.

The Knowles Loom Works have purchased the business of the George W. Stafford Manufacturing Company, Providence, R. I., builders of Jacquards, dobbies and narrow looms, and will move that business to Worcester and add it to their present works there.

The J. A. Fay & Egan Co., Cincinnati, O., write us that while business is fairly good, their work is mostly on foreign orders. This company has built up a large foreign trade in their large line of wood working machinery, and their orders from this source are always heavy.

J. A. Fay & Co., Cincinnati, O., issue a very handsome catalogue relating principally to sand-papering machines, although some other machines are illustrated. The paper is of a fine quality and the cuts are excellent. Several testimonials from representative houses are appended.

The sheet-mill, nail-mill, and the skelp-mill at the Wheeling (W. Va.) Steel and Iron Company are in operation. It will take about six weeks yet to complete the repairs at the steel plant, and by that time all three of the blast furnaces will also be in a condition for resumption.

The Bethlehem Iron Company recently shipped 64 tons of plate for the battle-ship "Maine" to the national proving grounds at Washington. The plates are 8x15 feet and 12 inches thick. These plates are the first service plates that have been Harveyized and their trial will consequently be of interest.

The Wanoosnoc Power Company, Fitchburg, Mass., has been organized with the following officers: President, D. Simonds; treasurer and clerk, G. M Holman; directors, D. Simonds, G. M. Holman, G. W. Holman, C. A. Hubbell, A. T. Gifford. The capital of the new company is $20,000, and they have a fine water power on Wanoosnoc brook. They propose to generate electricity at a power house and transmit to manufactories in the city.

The Cleveland *Iron Trade Review* finds no new developments in the iron trade. Prices have not declined since the last report, and it is probable that more mill capacity is active to-day than at any time since the June shut-down. Reductions in steel may lead to contracting. Car builders will soon have to make winter contracts, and eastern shipbuilders are active. The iron market is a wasting one. Some ore held as collateral which has been put on the market has weakened it.

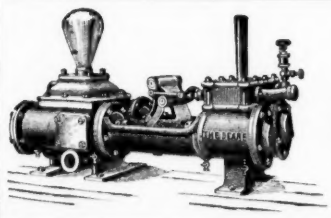
The following from the company named explains itself: "Hereafter, all machines made by the Egan Company, of Cincinnati, O., builders of wood-working machinery, will have placed upon them a number, commencing from 50,000 and then onward. The immense output of machines made by this company causes this step, so that when repairs are ordered the mere mention of the number of the machine brings forward its record—that is, its pattern and class, for a complete record is made of every machine that goes out. Delays in getting repairs cannot now happen. Improved machines, methods and systems are always in demand, and that is what the Egan Company offer."

Nearly every manufacturer of steam engine indicators issues a book of instruction which is furnished free to the purchaser of an instrument. The little book of this kind issued by the Crosby Steam Valve and Gage Co., of Boston, Mass., seems to be a very good one for the purpose, containing a description of the Crosby Indicator, its care, manner of attaching, how to use the planimeter, how to find the horse-power and other particulars of interest. This is contained in part first of the book. Part second contains articles on engine and boiler tests, calculations for steam consumption, etc., the whole supplemented with brief descriptions of some of the standard products of the company.

The Hurlbut-Rogers Machine Co., of South Sudbury, Mass., announce that they have recently purchased of the Brown & Sharpe Mfg. Co. the patent covering the fundamental principle of automatic variable speed devices as applied to lathes and cutting-off machines. The former have been experimenting for some two years on the application of such a device to cutting-off machines, and have now perfected a machine which is meeting with marked favor wherever it has been used, and which they are now putting on the market. They exhibited a 4" machine with automatic accelerated speed at the World's Fair which easily cuts soft steel 3" diameter in three minutes, and attracted much attention, and their exhibit was awarded a diploma and medal.

A Niagara Falls dispatch says: After a protracted and exhaustive examination of many plans submitted by the various electrical companies in America and Europe, the Niagara Falls Power Company has awarded to the Westinghouse Company, of Pittsburgh, Pa., a contract covering the construction and installation of three alternating current dynamos of 5,000 horse-power each, after designs originating with the engineer of the Cataract Construction Company, and especially adapted to the particular requirement of the hydraulic installation of the Niagara Falls Power Company. The system adopted involves the use of two phase currents with a frequency of 25 periods per second generated at a voltage of 2,000, and the use of transformers for long distance transmission at higher tension. The dynamos are the largest ever contracted for, and will be the largest in the world when completed.

A Johnstown, Pa., dispatch says: The Johnson Iron Company, which has been running all summer on about half time, to-night resumed operations on double turn. The company employ from 1,500 to 2,000 men. The resumption practically means a marked revival of business at the Cambria Iron Works, which depends on the Johnson Company for many of its orders for steel. When running full turn the Cambria Company employs from 7,000 to 8,000 men. The resumption at the Johnson Works gives encouragement to the hope that the panic is actually ended so far as the industrial depression is concerned. There is increased activity among the mills over last week, and it is asserted that fully 15,000 more men are at work in the various factories of Allegheny County



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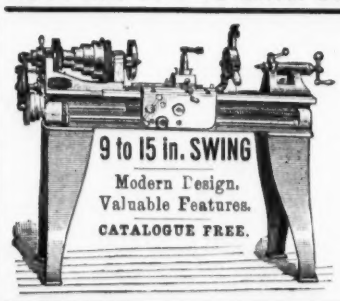

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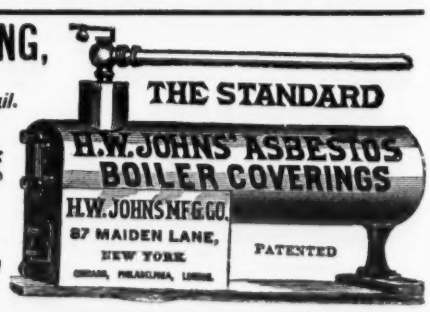

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42 INCH SWING, WITH TURRET HEAD, AND SCREW CUTTING ATTACHMENT.
All gears accurately cut. All feeds positive.
Machines are self-contained and therefore do not require an expensive foundation.
BRIDGEPORT MACHINE TOOL WORKS,
E. P. BULLARD, Prop. BRIDGEPORT, CONN.
New York Office, 39 CORTLANDT STREET, ROOM 86.

than were engaged in wage earning on the 1st of October. There is not an idle mill along the south side river front at present, for the first time in six months. None of the mills are working full, however, and at several only one or two departments are operating.

The Tradesman, Chattanooga, Tenn., in its review of the industrial situation in the South for the week ending October 23d, reports that a slight increase in business and a more favorable outlook is indicated from the mineral districts of Alabama, Georgia and Tennessee, that crop reports from the gulf region and from the Mississippi Valley show a decrease in production, and that the average of the past two weeks has been maintained in the organization of new industries throughout the South. There is no change of importance to report in general business. Money is in sufficient supply, but there is a want of inclination to enlarge transactions in the present unsettled condition of financial affairs. *The Tradesman* reports thirty new industries as established or incorporated during the week, together with six enlargements of manufactories, and eight important new buildings. The most important new industries reported for the week are the car works at Memphis, Tenn., to be established by the Litchfield Car Company, of Litchfield, Ill., with $600 000 capital; the Bloom Oil and Gas Company, of Wheeling, W. Va., capital, $500,000, by Jno. Waterhouse and others; the Standard Carbonating and Supply Company, of Atlanta, Ga , capital, $100,000, by H. Benjamin and others; the Hancock Disk Plow Company, of Shreveport, La., capital, $100,000, by M. T. Hancock and others; a $75,000 electric lighting plant, at Jacksonville, Fla., to be built by the city, and also one in contemplation at Atlanta, Ga.; a fiber-mill, tannery and extract works, with $50,000 capital, at Savannah, Ga., by the Palmetto Manufacturing Company; the Southern Pine Lumber Company, of Texarkana, Ark., capital, $50 000, by J. M. Park and associates; the Darlington Brick Company, of Darlington, S. C., capital, $50,000, by C. S. McCullough and others, and also a brick plant at Elk City, W. Va., by the Kanawha Brick Company; the Chicago Oil and Gas Company, of Sistersville, W. Va., capital, $50,000, and also a $25,000 planing mill and builders' supply company at Macon, Ga.; a $25,000 lumber company at Huling, W. Va.; a $15,000 machine shop at West Point, Ga.; a cotton rope factory at Florence, Ala., and a machine shop at Chattanooga, Tenn.

Machinists' Supplies and Iron.

NEW YORK, November 1, 1893.

Iron—American Pig—We quote Standard Northern brands, No. 1 Foundry, $14.50 to $15.00; No. 2, $13.50 to $14.25; Gray Forge, $12.25 to $12.50. Southern brands of good quality are obtainable at $13.75 to $14.50 for No. 1 Foundry; $12.50 to $13.50 for No. 2, and $11.75 to $12.50 for Gray Forge.

Antimony—The market is quiet and easy. We quote L. X., 9¾c. to 9¾c.; Cookson's, 10c. to 10⅛c.; Hallett's, 9.50c. to 9.55c., and U. S. French Star, 10c.

Lard Oil—Prime City is quoted at 78c. to 80c.

Copper—The market is quiet but steady. Lake Copper is quoted at 9¾c. Holders are firm in their views. Casting Copper is held at 9.20c. to 9.40c.

Lead—The market is dull but steady. Holders are asking 3.45c to 3.50c. Buyers are a little more reluctant.

Spelter—The market is irregular and dull. Some business has been done at 3.60c. to 3.65c. for New York delivery. For future delivery 3.67½c. has been bid.

Tin—The market continues in favor of the buyers. There are bids at 20.40c. for spot and November, and 20.55c. for December.

WANTED

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Situation wanted by first-class pattern maker. Address Patterns, AMERICAN MACHINIST.

Mech'l d'f'tsman, 10 years' exp., want position; accurate, highest refs., tech. grad. of Sweden, shop practice. Address BOX 124, AM. MACHINIST.

Want a pos. in drawing room or mach. shop, where I can obtain prac. exp.; understand mech. drawing, have had some shop practice. Willing to start on small salary. B., AMERICAN MACHINIST.

Wanted—Thoroughly competent foreman for established job foundry who can invest $5,000 in the business; foundry equipped with all modern improvements. Address A. P. H., AM. MACHINIST.

Situation wanted by a first-class mechanical engineer and draftsman; Swedish graduate; 8 years' American and European practice; steam engines and boilers preferred; finest refs. Box 123, AM. MACH.

Wanted—Position as superintendent by a man with long experience in equipping plants, reducing cost and systematic methods and handling men; best of refs. Address A. C. B., care AMER. MACH.

✣ MISCELLANEOUS WANTS ✣

Advertisements will be inserted under this head at 35 cents per line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Cheap 2d hd lathes & planers. S. M. York, Clev'd, O.

Auto. Steam Flue Cleaners. Kelley Co., Erie, Pa.

For Sale—Second-hand drill presses, engine lathes & planers. Dietz. Schumacher & Co., Cincinnati, O.

Light and fine machinery to order; Foot Lathe Catalogue for stamp. E. O. Chase, Newark, N. J.

Draftsmen's new comb. triangles, etc.; cir. free; small sample, 10c. D. J. Kelsey, New Haven, Conn.

Wanted—Light machinery or specialties to build. P. G. Fleming's Machine Works, Elizabeth, N. J.

For Sale—One 27"x14 foot bed screw-cutting engine lathe. A splendid tool in first-class condition. C. M. & J. B. Hart, Clarksburg, W. Va.

Wanted—A 30 H. P. engine, boiler and lot of shafting in exchange for dividend-paying gold mining stock. J. H. Allen, 244 Washington St., Boston, Mass.

For Sale—A small machine shop well equipped with first-class machines and tools. For particulars address H. F. Quickel, P. O. Box 27, Harrisburg, Pa.

Wanted—A portable saw-mill suitable for sawing timber for mining purposes in exchange for dividend-paying gold mining stock. Address J. H. Allen, 244 Washington St., Boston, Mass.

"Threads and Gears," by G. W. Dixon, with rules to cut any screw thread in the lathe that can be cut without the use of algebra, will be sent to any address on receipt of price, 50 cents. G. W. Dixon, Spring Lake, Mich.

Introduction and negotiation of American patents and machinery to English manufacturers and agents. Write for circular to Geo. Richards, M. I. M. E., Mechanical and Consulting Engineer, No. 5 Laurence Pountney Hill, London, England.

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FOR SALE OR TO LET.
210 E. 43d St., NEW YORK.
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3000
VARIETIES FILES
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Ready Made Cut Gears.
Ready Made Cast Gears.
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Gears Made to Order.
Gear Cutting.
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Treatise on Gears, $1.00.
Gear Cutting Machines.
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and 125 South 11th St.,
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REDUCED PRICE OF LE COUNT'S
HEAVY STEEL DOG
Le Count's Heavy Steel Dog.
With Steel Screws, Lathe Made and Hardened.
When ordering, state as above, whether a full set or a set of 12, or small set of 8. Users of these dogs prefer them to any other make.
This Dog has a Very Heavy Boss, so that if the thread wears a Heavier Screw can be substituted.

No.	Inch.	Price.
1	3-8	$ .40
2	1-2	.50
3	5-8	.60
4	3-4	.60
5	7-8	.70
6	1	.70
7	1 1-8	.80
8	1 1-4	.80
9	1 3-8	.95
10	1 1-2	.95
11	1 3-4	1.10
12	2	1.20
13	2 1-4	1.35
14	2 1-2	1.45
15	3	1.60
16	3 1-2	1.80
17	4	2.10
18	4 1-2	2.75
19	5	3.25
Full set of 19		$21.60
20 (ext.)	5 1-2	4.00
21 (ext.)	6	5.00

One Small Set of 8—by 1-4 inches to 20 inch, $6.25
One Set of 12—by 1-4 in. to 2 in. continued by 1-2 in. to 4 in. 13.25
These goods are for sale by CHAS. CHURCHILL & CO., L'td, 21 Cross St., London, England.

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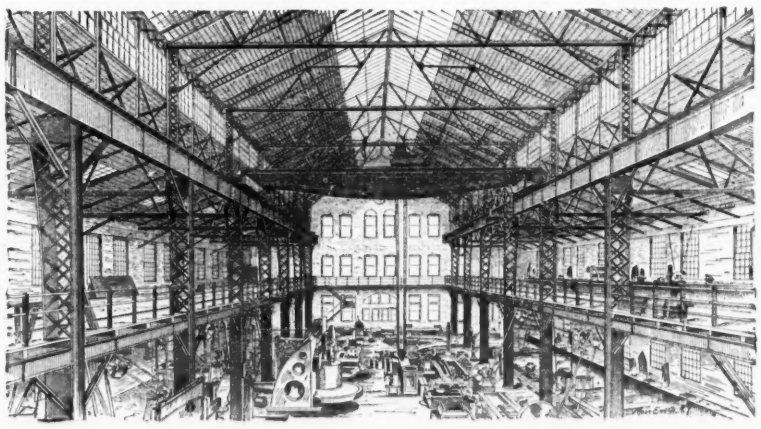
Engineers, Architects and Builders of

Iron and Steel Bridges and Buildings.
The above illustration (taken direct from a photograph) shows the interior of a Machine Shop built by us for The Lake Erie Engineering Co., at Buffalo, N. Y. The building is 106 feet in width, the center span is 50 feet in width with a wing on each side 28 feet in width. A power crane controls the floor the entire length of the central portion. The roof is covered with slate on iron purlins. The side walls are of brick. The interior is lighted by skylights in the roof.
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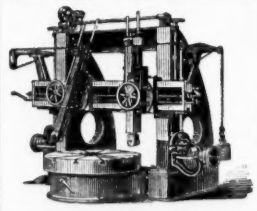
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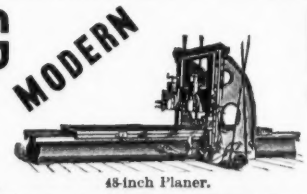
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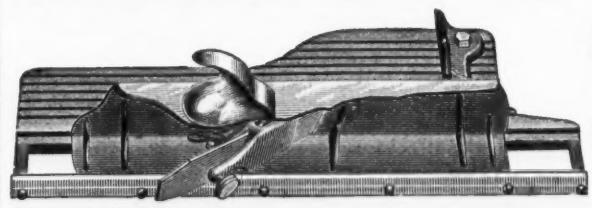
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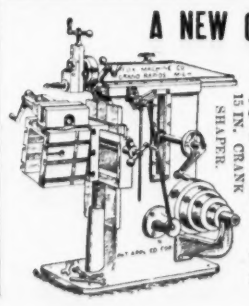
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Screw Cutting Automatic Cross Feed, etc.
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ONLY APPARATUS that can MAINTAIN a VACUUM on ENGINES and ELEVATE the discharge WATER to TANK at any height.
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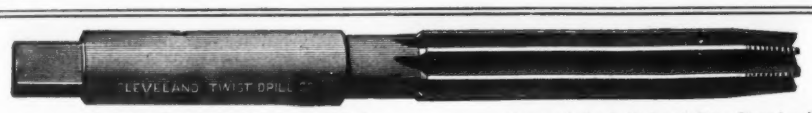

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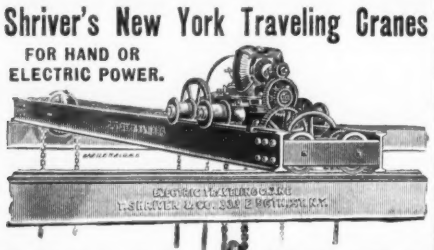

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1 Radial Drill about 40" swing.
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1 Planer about 30" x 6' bed, also 3 lathes one 19", one 30" and one 36".
Good second-hand tools will do.
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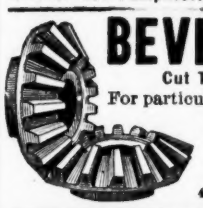

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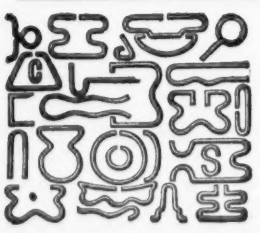

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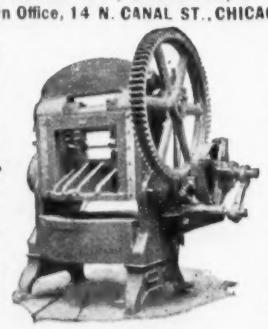

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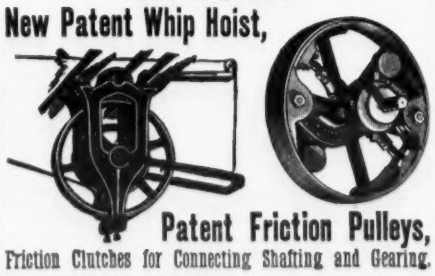

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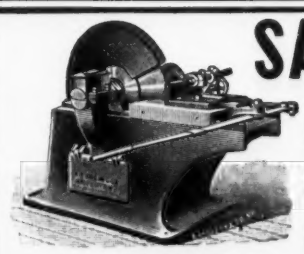

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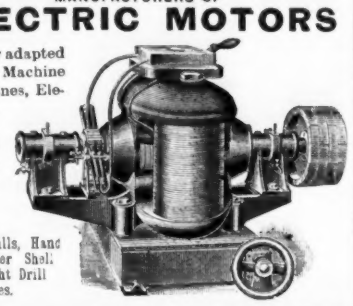

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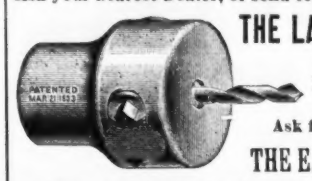

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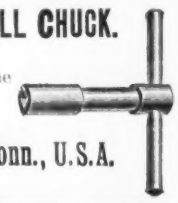

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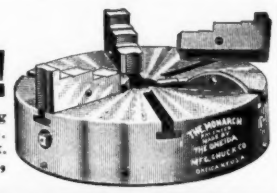

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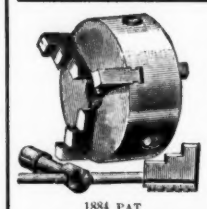

1884 PAT

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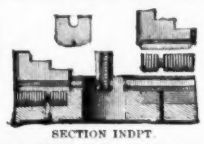

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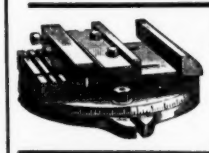

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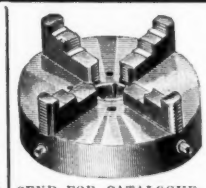

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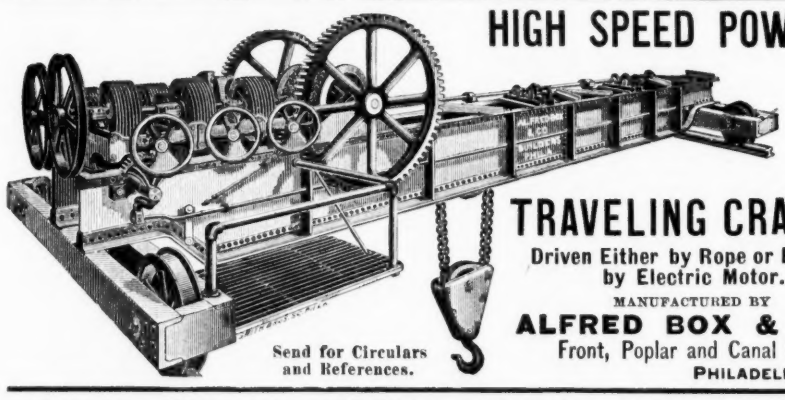

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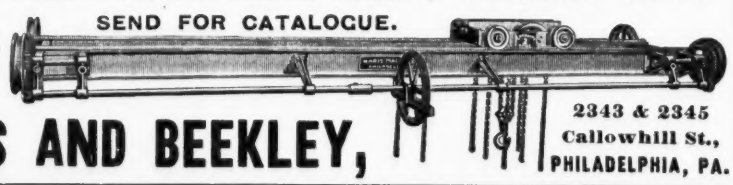

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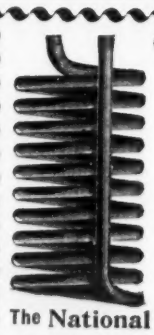

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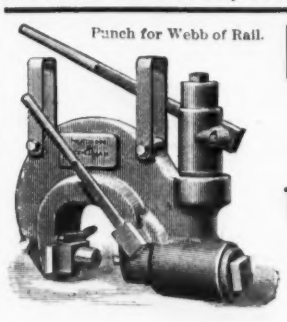

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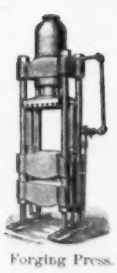

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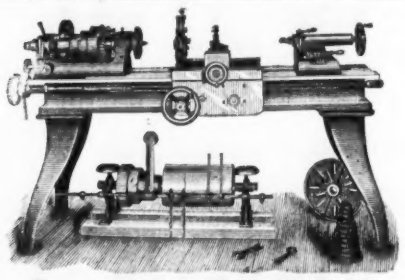

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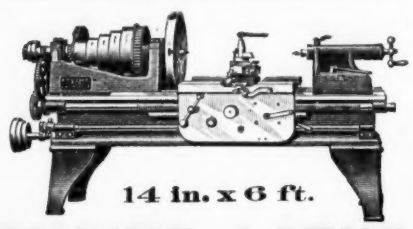

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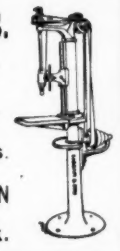

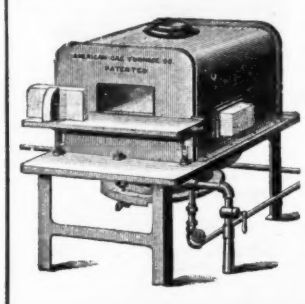

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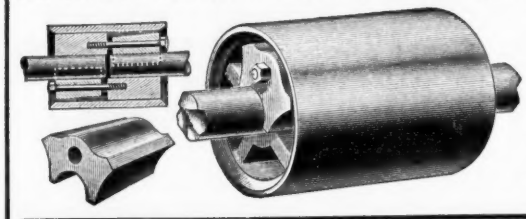

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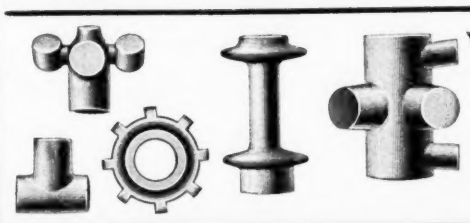

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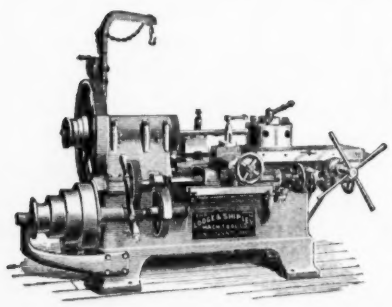

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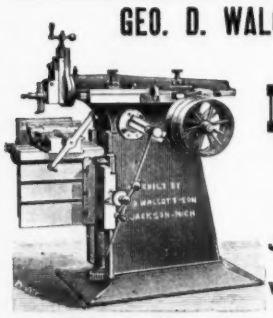

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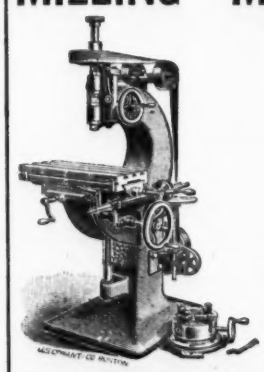

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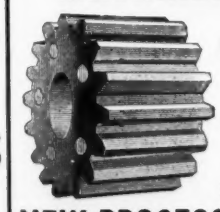

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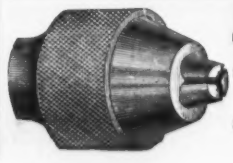

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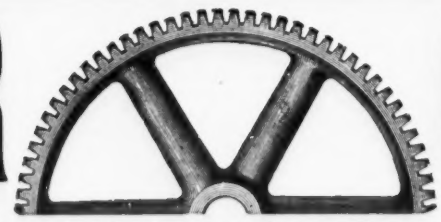

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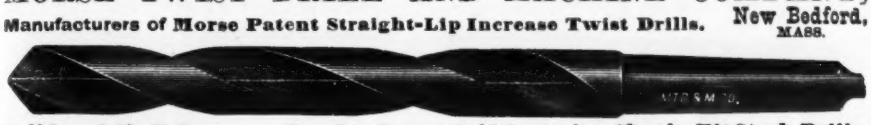

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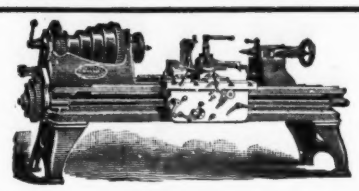

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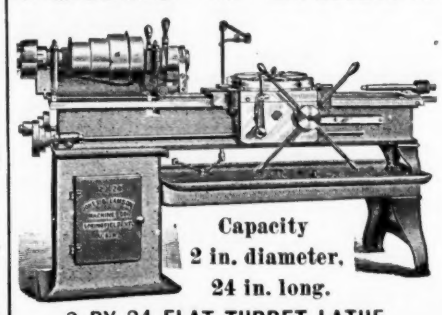

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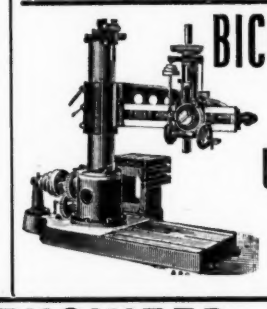

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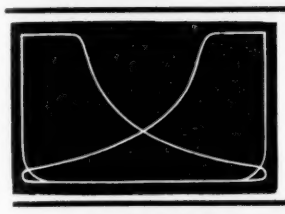

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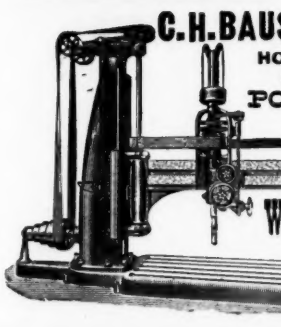

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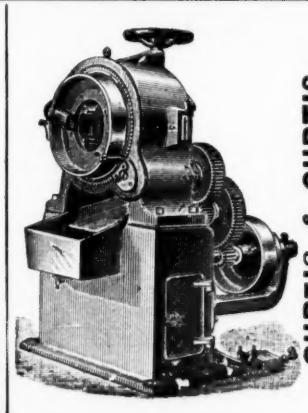

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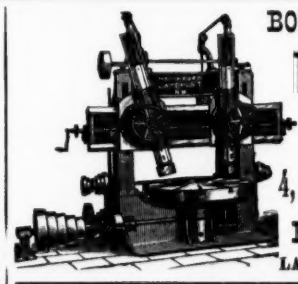

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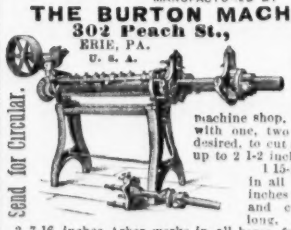

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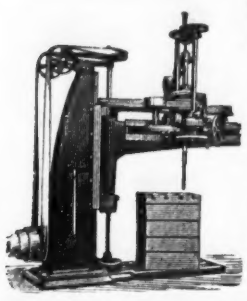

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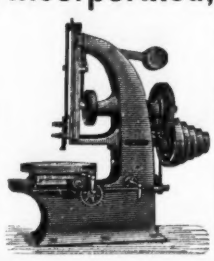

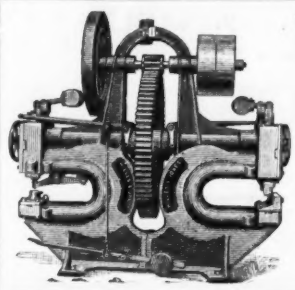

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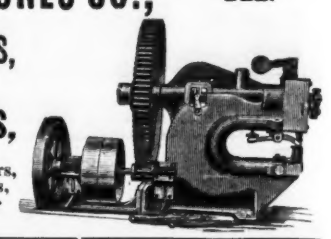

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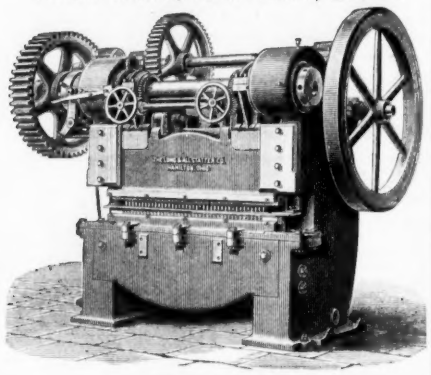

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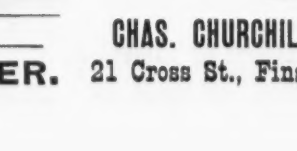

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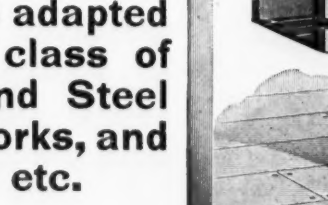

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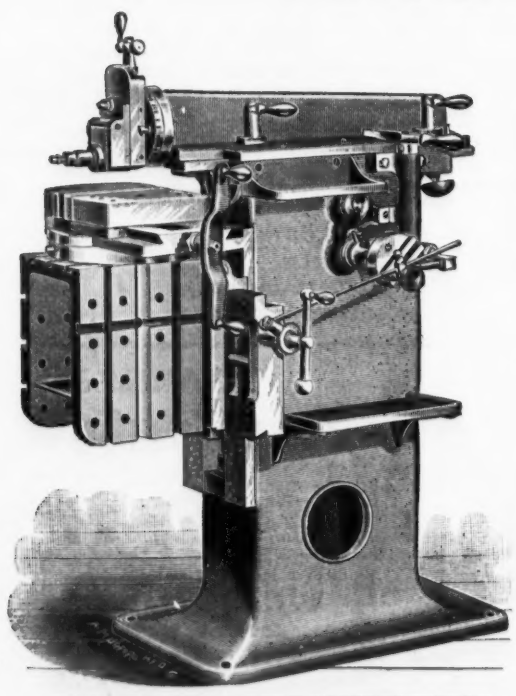

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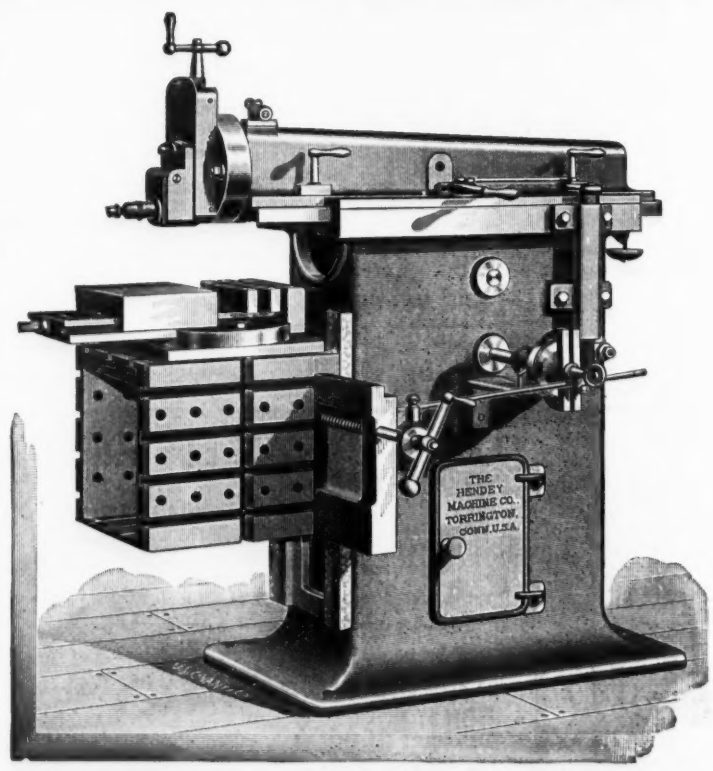

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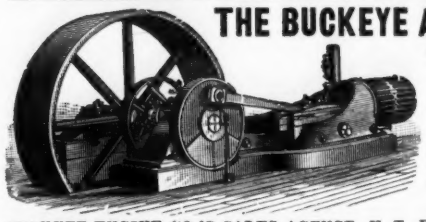

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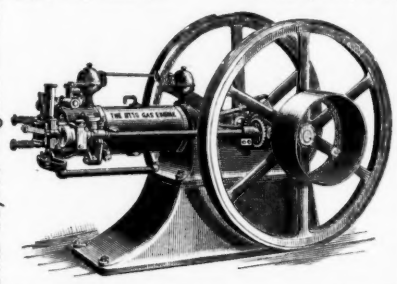

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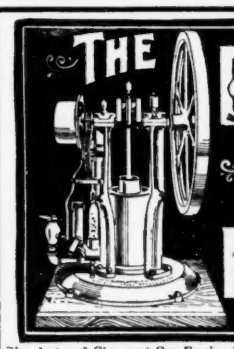

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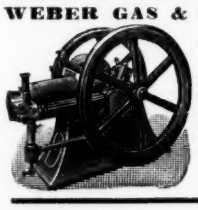

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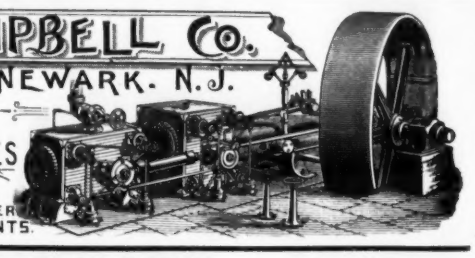

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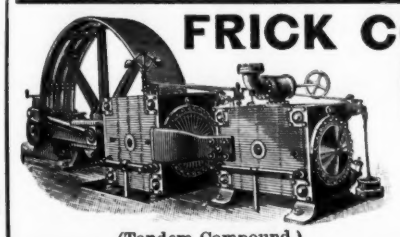

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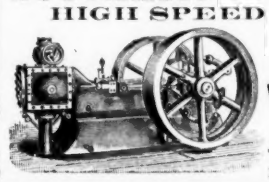

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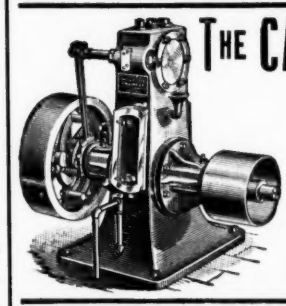

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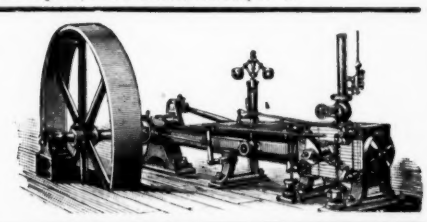

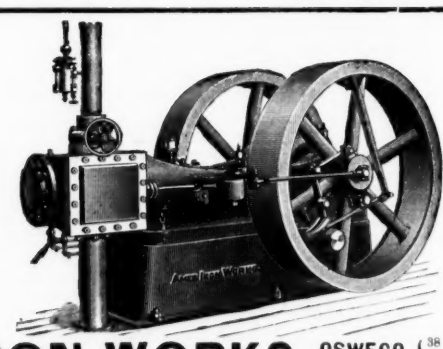

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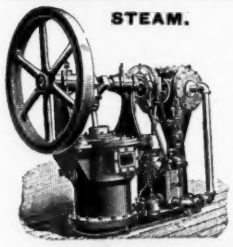
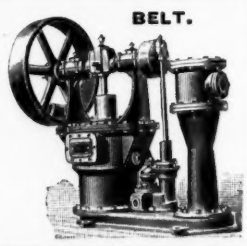


BELT.



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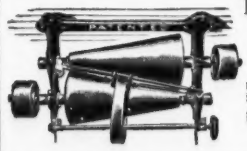

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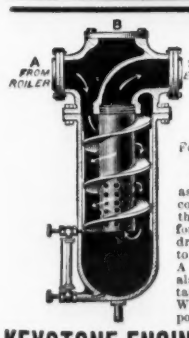

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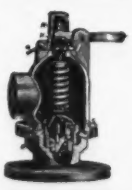

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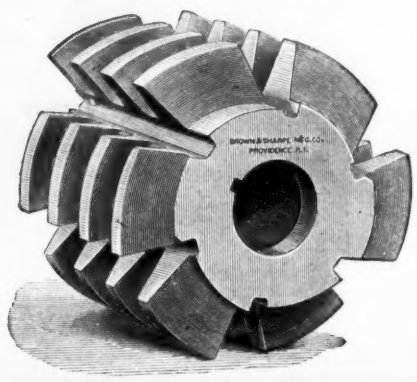

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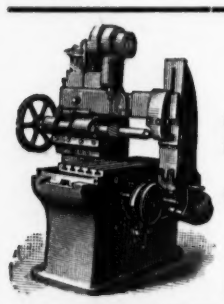

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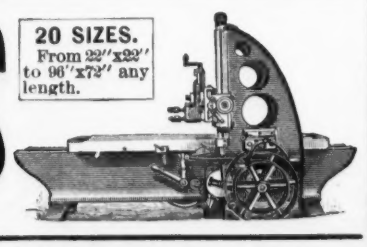

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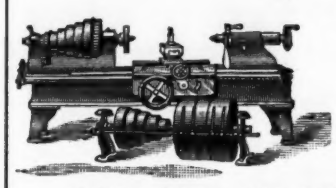

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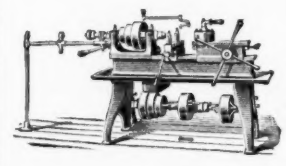

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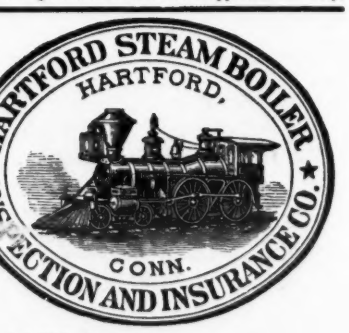

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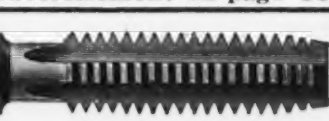

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